STANDARD SPECIFICATIONS

for

ROAD AND BRIDGE CONSTRUCTION

STATE OF NEVADA
DEPARTMENT OF HIGHWAYS
CARSON CITY
1968

PROPERTY
OF
BUREAU OF PUBLIC ROADS
LIBRARY
▽

Book No. _____

PR-770 a
(Rev. 7-67)

16—31629-5 GPO

Standard specifications for road and bridge construction / State of Nevada, Department of Highways.
NDOT HQ Library - Carson City
08016089

APPROVED: AUG 1 6 1968
Director of Public Roads

By _____
Director of Engineering and Operations

This is a duplicate of the copy approved and returned on AUG 1 6 1968

PROPERTY OF
NDOT TRANSPORTATION LIBRARY

APPROVED SUBJECT TO EXCEPTIONS AND/OR CONDITIONS SET FORTH IN MEMORANDUM G. M. WILLIAM TO Schofer DATED AUG 1 6 1968.

WITHDRAWN

39

TE
5062
.N3N3
1968

STATE OF NEVADA
DEPARTMENT OF HIGHWAYS

BUREAU OF PUBLIC ROADS
RECEIVED
AUG 21 1968
LIBRARY

Standard Specifications for Road and Bridge Construction

JOHN E. BAWDEN
State Highway Engineer

DIRECTORS

PAUL LAXALT, *Governor,* Chairman
HARVEY DICKERSON, *Attorney General*
WILSON MCGOWAN, *State Controller*

452

CARSON CITY, NEVADA
1968

SPO, Carson City, Nevada, 1967

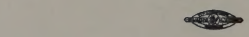


TABLE OF CONTENTS

DIVISION I—GENERAL REQUIREMENTS

SECTION 101—DEFINITIONS AND TERMS

		PAGE
101.01	Abbreviations	1
101.02	Advertisement	2
101.03	Award	2
101.04	Bidder	2
101.05	Bridge	2
101.06	Calendar Day	3
101.07	Contract Change Order	3
101.08	Channel	3
101.09	Contract	3
101.10	Contract Bond	3
101.11	Contract Item (Pay Item)	3
101.12	Contractor	3
101.13	Contract Time	4
101.14	Culvert	4
101.15	Department	4
101.16	Detour	4
101.17	Directors	4
101.18	Divided Highway	4
101.19	Employee	4
101.20	Engineer	4
101.21	Equipment	4
101.22	Extra Work	5
101.23	Frontage Road or Frontage Street	5
101.24	Highway	5
101.25	Holidays	5
101.26	Inspector	5
101.27	Laboratory	5
101.28	Major Contract Item	5
101.29	Materials	6
101.30	Median	6
101.31	Notice to Contractors	6
101.32	Notice to Proceed	6
101.33	Plans	6
101.34	Profile Grade	6
101.35	Project	6
101.36	Proposal	6
101.37	Proposal Form	6
101.38	Proposal Guaranty	6
101.39	Right of Way	7
101.40	Road	7
101.41	Roadbed	7

CONTENTS

	General Requirements—*Continued*	Page
101.42	Roadside	7
101.43	Roadside Development	7
101.44	Roadway	7
101.45	Shoulder	7
101.46	Sidewalk	7
101.47	Special Provisions	7
101.48	Specifications	8
101.49	State	8
101.50	Street	8
101.51	Structures	8
101.52	Subcontractor	8
101.53	Subgrade	8
101.54	Substructure	8
101.55	Superintendent	8
101.56	Superstructure	8
101.57	Supplemental Agreement	9
101.58	Supplemental Specifications	9
101.59	Surety	9
101.60	Traffic Lane	9
101.61	Traveled Way	9
101.62	Work	9
101.63	Working Day	9
101.64	Working Drawings	10
101.65		10

SECTION 102—BIDDING REQUIREMENTS AND CONDITIONS

102.01	Notice to Contractors	11
102.02	Prequalification of Bidders	11
102.03	Contents of Proposal Forms	12
102.04	Interpretation of Quantities in the Proposal	13
102.05	Examination of Plans, Specifications, Contract Documents, and Site of Work	13
102.06	Preparation of Proposal	14
102.07	Irregular Proposals	15
102.08	Proposal Guaranty	16
102.09	Delivery of Proposals	16
102.10	Withdrawal or Revision of Proposals	16
102.11	Public Opening of Proposals	16
102.12	Disqualification of Bidders	17
102.13	Material Guaranty	17
102.14	Combination or Conditional Bids	17
102.15	Motor Fuel Tax Refund	18

SECTION 103—AWARD AND EXECUTION OF CONTRACT

103.01	Consideration of Proposals	19
103.02	Award of Contract	19

GENERAL REQUIREMENTS—*Continued*

		PAGE
103.03	Cancellation of Award	19
103.04	Return of Proposal Guaranty	20
103.05	Requirement of Contract Bond	20
103.06	Execution and Approval of Contract	21
103.07	Failure to Execute Contract	21

SECTION 104—SCOPE OF THE WORK

104.01	Intent of the Contract	23
104.02	Increased or Decreased Quantities and Change in Character of Work	23
104.03	Extra Work	25
104.04	Maintenance of Traffic	25
104.05	Rights in and Use of Materials Found on the Work	28
104.06	Final Clean Up	28

SECTION 105—CONTROL OF WORK

105.01	Authority of the Engineer	31
105.02	Plans and Working Drawings	31
105.03	Conformity with Plans and Specifications	32
105.04	Coordination of Plans, Specifications, Supplemental Specifications, and Special Provisions	33
105.05	Cooperation by Contractor	33
105.06	Cooperation with Utilities	34
105.07	Cooperation Between Contractors	35
105.08	Construction Stakes, Lines and Grades	35
105.09	Authority and Duties of the Resident Engineer	36
105.10	Duties of the Inspector	36
105.11	Inspection	36
105.12	Removal of Unacceptable and Unauthorized Work	37
105.13	Load and Speed Restrictions	38
105.14	Maintenance During Construction	40
105.15	Failure to Maintain Roadway or Structure	40
105.16	Final Acceptance	41
105.17	Claims for Adjustment and Disputes	41

SECTION 106—CONTROL OF MATERIAL

106.01	Source of Supply and Quality Requirements	43
106.02	Local Materials	44
106.03	Possible Local Material Sources	44
106.04	Samples and Tests	48
106.05	Certificates of Compliance	51
106.06	Cited Specifications	51
106.07	Plant Inspection	52
106.08	Storage of Materials	52
106.09	Handling Materials	53
106.10	Unacceptable Materials	53
106.11	Department Furnished Material	54

CONTENTS

GENERAL REQUIREMENTS—*Continued*

SECTION 107—LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

		PAGE
107.01	Laws to be Observed	55
107.02	Permits, Licenses, and Taxes	55
107.03	Patented Devices, Materials, and Processes	55
107.04	Restoration of Surfaces Opened by Permit	56
107.05	Federal Aid Provisions	56
107.06	Sanitary Provisions	57
107.07	Public Convenience and Safety	57
107.08	Relations with Railroads	58
107.09	Liability Insurance	61
107.10	Explosives	62
107.11	Responsibility for Damage Claims	63
107.12	Protection and Restoration of Property and Landscape	64
107.13	Forest Protection	66
107.14	Disposal of Material Outside Highway Right of Way	67
107.15	Relief from Maintenance and Responsibility	68
107.16	Contractor's Responsibility for the Work and Materials	69
107.17	Contractor's Responsibility for Utility Property and Service	70
107.18	Furnishing Right of Way	71
107.19	Personal Liability of Public Officials	71
107.20	No Waiver of Legal Rights	71
107.21	Dust Nuisance	72

SECTION 108—PROSECUTION AND PROGRESS

108.01	Subletting of Contract	73
108.02	Notice to Proceed	74
108.03	Prosecution and Progress	75
108.04	Limitation of Operations	75
108.05	Character of Workmen; Methods and Equipment	76
108.06	Temporary Suspension of Work	77
108.07	Preconstruction Conference	79
108.08	Determination and Extension of Contract Time	79
108.09	Failure to Complete the Work on Time	80
108.10	Default and Termination of Contract	81
108.11	Termination of the Contractor's Responsibility	82
108.12	Right of Way Delays	82

SECTION 109—MEASUREMENT AND PAYMENT

109.01	Measurement of Quantities	85
109.02	Scope of Payment	92
109.03	Extra and Force Account Work	94
109.04	Eliminated Items	96

GENERAL REQUIREMENTS—*Continued* PAGE
109.05 Common Carrier Rate Adjustments ... 96
109.06 Partial Payment ... 97
109.07 Acceptance and Final Payment ... 100

SECTION 110—WAGES AND CONDITIONS OF EMPLOYMENT

110.01 Description ... 103
110.02 Laws Cited ... 103

DIVISION II—CONSTRUCTION DETAILS

SECTION 201—CLEARING AND GRUBBING

Description
201.01.01 General ... 105

Construction
201.03.01 General ... 105
201.03.02 Areas to be Cleared ... 105
201.03.03 Clearing and Grubbing ... 106

Method of Measurement
201.04.01 Measurement ... 107

Basis of Payment
201.05.01 Payment ... 108

SECTION 202—REMOVAL OF STRUCTURES AND OBSTRUCTIONS

Description
202.01.01 General ... 111

Construction
202.03.01 General ... 111
202.03.02 Removal ... 111
202.03.03 Extensions ... 112
202.03.04 Closing Culverts ... 113
202.03.05 Salvage ... 113
202.03.06 Disposing of Materials ... 114

Method of Measurement
202.04.01 Measurement ... 115

Basis of Payment
202.05.01 Payment ... 115

SECTION 203—EXCAVATION AND EMBANKMENT

Description
203.01.01 General ... 117

CONTENTS

CONSTRUCTION DETAILS—*Continued*

		PAGE
Materials		
203.02.01	Roadway Excavation	117
203.02.02	Drainage Excavation	117
203.02.03	Channel Excavation	117
203.02.04	Borrow	118
Construction		
203.03.01	Roadway	118
203.03.02	Unsuitable Material	118
203.03.03	Blasting	119
203.03.04	Rock Cuts	119
203.03.05	Overbreak	120
203.03.06	Slopes	120
203.03.07	Widening Cuts	120
203.03.08	Surplus Material	120
203.03.09	Selected Material	121
203.03.10	Slides and Slipouts	122
203.03.11	Drainage	122
203.03.12	Channels	123
203.03.13	Borrow	123
203.03.14	Foundation	125
203.03.15	Embankment Material	125
203.03.16	Placing Embankment	126
203.03.17	Compaction, Dirt Embankment	128
203.03.18	Compaction, Rock Embankment	129
203.03.19	Maintenance	134
Method of Measurement		
203.04.01	Measurement	134
Basis of Payment		
203.05.01	Payment	137

SECTION 204—ROUNDED AND TRANSITION SLOPES

Description		
204.01.01	General	139
Construction		
204.03.01	General	139
Method of Measurement		
204.04.01	Measurement	140
Basis of Payment		
204.05.01	Payment	140

SECTION 205—OVERHAUL

Description		
205.01.01	General	141

CONSTRUCTION DETAILS—*Continued*

Method of Measurement PAGE
205.04.01 Measurement ... 141

Basis of Payment
205.05.01 Payment ... 141

SECTION 206—STRUCTURE EXCAVATION

Description
206.01.01 General ... 143
206.01.02 Classification ... 143

Construction
206.03.01 General ... 144
206.03.02 Inspection ... 145

Method of Measurement
206.04.01 Measurement ... 145

Basis of Payment
206.05.01 Payment ... 145

SECTION 207—BACKFILL

Description
207.01.01 General ... 147

Materials
207.02.01 Backfill ... 147
207.02.02 Granular Backfill ... 147

Construction
207.03.01 General ... 148
207.03.02 Placing and Compacting at Abutments, Piers, Wingwalls and Retaining Walls ... 149
207.03.03 Placing and Compacting at Culverts ... 149
207.03.04 Placing and Compacting of Bin-Type Retaining Walls ... 150

Method of Measurement
207.04.01 Measurement ... 150

Basis of Payment
207.05.01 Payment ... 150

SECTION 208—FOUNDATION FILL

Description
208.01.01 General ... 153

Materials
208.02.01 General ... 153

CONTENTS

CONSTRUCTION DETAILS—*Continued*

Construction PAGE

208.03.01 General ... 153

Method of Measurement

208.04.01 Measurement ... 153

Basis of Payment

208.05.01 Payment ... 154

SECTION 209—DRAIN BACKFILL

Description

209.01.01 General ... 155

Materials

209.02.01 General ... 155

Construction

209.03.01 Underdrains ... 155

Method of Measurement

209.04.01 Measurement ... 155

Basis of Payment

209.05.01 Payment ... 156

SECTION 210—WATERING

Description

210.01.01 General ... 157

Materials

210.02.01 General ... 157

Construction

210.03.01 Equipment ... 157
210.03.02 General ... 157

Method of Measurement

210.04.01 Measurement ... 158

Basis of Payment

210.05.01 Payment ... 158

SECTION 211—EROSION CONTROL

Description

211.01.01 General ... 161

Materials

211.02.01 General ... 161
211.02.02 Top Soil ... 161
211.02.03 Seed ... 161

CONSTRUCTION DETAILS—*Continued*

PAGE
211.02.04 Fertilizer ... 161
211.02.05 Mulch ... 161
211.02.06 Asphalt Emulsion ... 162

Construction

211.03.01 Preparation ... 162
211.03.02 Placement of Top Soil ... 162
211.03.03 Compaction ... 163
211.03.04 Seeding and Fertilizing ... 163
211.03.05 Spreading Mulch ... 165
211.03.06 Applying Asphalt Emulsion ... 165
211.03.07 Placing Jute Matting ... 165

Method of Measurement

211.04.01 Measurement ... 166

Basis of Payment

211.05.01 Payment ... 167

SECTION 212—LANDSCAPING

Description

212.01.01 General ... 169

Materials

212.02.01 General ... 169
212.02.02 Nomenclature ... 169
212.02.03 Quality of Plant Materials ... 169
212.02.04 Handling and Shipping ... 170
212.02.05 Inspection of Plant Material ... 171
212.02.06 Substitution of Plants ... 171
212.02.07 Temporary Storage ... 171
212.02.08 Top Soil ... 172
212.02.09 Lumber ... 172

Construction

212.03.01 Site Preparation ... 172
212.03.02 Layout of Planting ... 172
212.03.03 Preparation of Planting Areas ... 172
212.03.04 Planting ... 174
212.03.05 Staking and Guying ... 177
212.03.06 Pruning ... 177
212.03.07 Watering ... 177
212.03.08 Replacements ... 179
212.03.09 Fertilizers and Additives ... 180
212.03.10 Protection of Existing Facilities ... 180
212.03.11 Plant Establishment Work ... 180

Method of Measurement

212.04.01 Measurement ... 181

CONTENTS

CONSTRUCTION DETAILS—*Continued*

Basis of Payment PAGE

212.05.01 Payment ... 182

SECTION 213—IRRIGATION SYSTEMS

Description

213.01.01 General ... 185

Materials

213.02.01 General ... 185
213.02.02 Pipe and Fittings ... 185
213.02.03 Control Tubing ... 185
213.02.04 Automatic Controllers ... 185
213.02.05 Sprinkler Heads ... 186
213.02.06 Valve Protection Sleeves ... 186
213.02.07 Gate Valves ... 187
213.02.08 Control Valves ... 187
213.02.09 Quick Coupler Valves ... 187
213.02.10 Valve Boxes ... 188
213.02.11 Backflow Preventers ... 188
213.02.12 Drain Valves ... 188
213.02.13 Hose Bibs ... 188
213.02.14 Vacuum Breakers ... 189

Construction

213.03.01 General ... 190
213.03.02 Excavation ... 190
213.03.03 Excavation Adjacent to Trees ... 190
213.03.04 Piping ... 191
213.03.05 Jointing ... 191
213.03.06 Control Tubing ... 191
213.03.07 Installation ... 192
213.03.08 Control Tubing Installation ... 194
213.03.09 Flushing and Testing ... 194
213.03.10 Adjusting System ... 195
213.03.11 Backfill ... 195

Method of Measurement

213.04.01 Measurement ... 195

Basis of Payment

213.05.01 Payment ... 196

SECTION 301—SELECTED MATERIAL BASE OR SURFACE

Description

301.01.01 General ... 197

Materials

301.02.01 General ... 197

CONSTRUCTION DETAILS—*Continued*

		PAGE
Construction		
301.03.01	Subgrade Preparation	197
301.03.02	Placing	197
301.03.03	Watering	198
301.03.04	Compaction	198
Method of Measurement		
301.04.01	Measurement	198
Basis of Payment		
301.05.01	Payment	199

SECTION 302—AGGREGATE BASE COURSES

Description		
302.01.01	General	201
Materials		
302.02.01	General	201
Construction		
302.03.01	Subgrade Preparation	201
302.03.02	Spreading Class A Aggregates	201
302.03.03	Spreading Class B Aggregates	202
302.03.04	Watering and Mixing Class A Aggregates	203
302.03.05	Watering Class B Aggregates	203
302.03.06	Compaction	203
302.03.07	Tolerance for Type 2 Class A Aggregate	204
Method of Measurement		
302.04.01	Measurement	204
Basis of Payment		
302.05.01	Payment	205

SECTION 303—PLANTMIX BITUMINOUS BASE

Description		
303.01.01	General	207
Materials		
303.02.01	General	207
Construction		
303.03.01	General	207
303.03.02	Rollers	207
303.03.03	Spreading and Finishing	208
303.03.04	Surface Tolerances	208
Method of Measurement		
303.04.01	Measurement	208

CONTENTS

CONSTRUCTION DETAILS—*Continued*

Basis of Payment PAGE

303.05.01 Payment ... 208

SECTION 304—PORTLAND CEMENT TREATED BASE

Description

304.01.01 General ... 211

Materials

304.02.01 General ... 211

Construction

304.03.01 Proportioning ... 211
304.03.02 Mixing—Roadmix Method ... 211
304.03.03 Mixing—Plantmix Method ... 213
304.03.04 Spreading ... 216
304.03.05 Compaction ... 218
304.03.06 Finished Surface ... 218
304.03.07 Time Requirements ... 219
304.03.08 Construction Joints ... 219
304.03.09 Protection and Curing ... 220
304.03.10 Weather Limitations ... 221

Method of Measurement

304.04.01 Roadmix Method Designated for Use ... 221
304.04.02 Plantmix Method Designated for Use ... 222
304.04.03 General ... 222

Basis of Payment

304.05.01 Roadmix Method Designated for Use ... 223
304.05.02 Plantmix Method Designated for Use ... 223
304.05.03 General ... 224

SECTION 401—PLANTMIX BITUMINOUS PAVEMENTS—GENERAL

Description

401.01.01 General ... 225

Materials

401.02.01 Composition of Mixtures ... 225
401.02.02 Aggregates ... 227
401.02.03 Commercial Mineral Filler ... 227
401.02.04 Bituminous Materials ... 227

Construction

401.03.01 Bituminous Mixing Plant ... 227
401.03.02 Hauling Equipment ... 234
401.03.03 Pavers ... 234
401.03.04 Rollers ... 235
401.03.05 Weather Limitations ... 236
401.03.06 Preparation of Existing Surface ... 236

CONSTRUCTION DETAILS—*Continued* PAGE

401.03.07 Preparation of Bituminous Materials 236
401.03.08 Preparation of Aggregates 236
401.03.09 Mixing 237
401.03.10 Spreading and Finishing 238
401.03.11 Rolling 239
401.03.12 Joints 240
401.03.13 Surface Tolerances 240
401.03.14 Surfacing Miscellaneous Areas 240

Method of Measurement

401.04.01 Measurement 241

Basis of Payment

401.05.01 Payment 242

SECTION 402—PLANTMIX BITUMINOUS SURFACE

Description

402.01.01 General 243

Materials

402.02.01 General 243

Construction

402.03.01 General 243
402.03.02 Rollers 243
402.03.03 Spreading and Finishing 244
402.03.04 Surface Tolerances 244

Method of Measurement

402.04.01 Measurement 244

Basis of Payment

402.05.01 Payment 245

SECTION 403—PLANTMIX BITUMINOUS OPEN-GRADED SURFACE

Description

403.01.01 General 247

Materials

403.02.01 General 247

Construction

403.03.01 General 247
403.03.02 Rollers 247
403.03.03 Joints 247
403.03.04 Surface Tolerances 248

Method of Measurement

403.04.01 Measurement 248

CONTENTS

CONSTRUCTION DETAILS—*Continued*

Basis of Payment PAGE

403.05.01 Payment 248

SECTION 404—ROADMIX BITUMINOUS SURFACE

Description

404.01.01 General 251

Materials

404.02.01 Aggregates 251
404.02.02 Bituminous Material 251

Construction

404.03.01 Motor Graders 252
404.03.02 Distributors 252
404.03.03 Mixing Plants 252
404.03.04 Rollers 252
404.03.05 Weather Limitations 252
404.03.06 Preparation of Existing Surface 253
404.03.07 Placing Aggregates 253
404.03.08 Application of Bituminous Material 254
404.03.09 Mixing 254
404.03.10 Spreading, Compacting, and Finishing 256
404.03.11 Miscellaneous Areas 257
404.03.12 Surface Tolerances 258

Method of Measurement

404.04.01 Measurement 258

Basis of Payment

404.05.01 Payment 259

SECTION 405—TACK COAT

Description

405.01.01 General 261

Materials

405.02.01 Bituminous Material 261

Construction

405.03.01 Equipment 261
405.03.02 Weather Limitations 261
405.03.03 Preparation of Surface 262
405.03.04 Application of Bituminous Materials 262

Method of Measurement

405.04.01 Measurement 263

Basis of Payment

405.05.01 Payment 263

CONSTRUCTION DETAILS—*Continued*

SECTION 406—PRIME COAT

Description PAGE

406.01.01 General ... 265

Materials

406.02.01 Bituminous Material ... 265
406.02.02 Sand Blotter ... 265

Construction

406.03.01 Equipment ... 265
406.03.02 Weather Limitations ... 265
406.03.03 Preparation of Surface ... 266
406.03.04 Application of Bituminous Material ... 266
406.03.05 Application of Blotter Material ... 267

Method of Measurement

406.04.01 Measurement ... 267

Basis of Payment

406.05.01 Payment ... 267

SECTION 407—SEAL COAT

Description

407.01.01 General ... 269

Materials

407.02.01 Bituminous Material ... 269
407.02.02 Sand Blotter ... 269

Construction

407.03.01 Equipment ... 269
407.03.02 Weather Limitations ... 269
407.03.03 Preparation of Surface ... 270
407.03.04 Application of Bituminous Material ... 270
407.03.05 Application of Blotter Material ... 270

Method of Measurement

407.04.01 Measurement ... 270

Basis of Payment

407.05.01 Payment ... 271

SECTION 408—SURFACE TREATMENT

Description

408.01.01 General ... 273

Materials

408.02.01 Bituminous Material ... 273
408.02.02 Screenings ... 273

CONTENTS

CONSTRUCTION DETAILS—*Continued*

		PAGE
Construction		
408.03.01	Distributors	273
408.03.02	Aggregate Spreader	273
408.03.03	Rollers	273
408.03.04	Weather Limitations	274
408.03.05	Maintaining Traffic	274
408.03.06	Preparation of Surface	274
408.03.07	Application of Bituminous Material	275
408.03.08	Application of Screenings	275
408.03.09	Rolling	276
Method of Measurement		
408.04.01	Measurement	277
Basis of Payment		
408.05.01	Payment	277
SECTION 409—PORTLAND CEMENT CONCRETE PAVEMENT		
Description		
409.01.01	General	279
Materials		
409.02.01	General	279
409.02.02	Gradation Requirements	279
409.02.03	Concrete Properties and Tests	280
Construction		
409.03.01	Classification and Proportions	280
409.03.02	Equipment	282
409.03.03	Preparation of Grade	287
409.03.04	Setting Forms	287
409.03.05	Reinforcement	288
409.03.06	Mixing	288
409.03.07	Placing Concrete	289
409.03.08	Spreading, Compacting, and Shaping	290
409.03.09	Joints	292
409.03.10	Finishing	296
409.03.11	Riding Tolerances	299
409.03.12	Curing	300
409.03.13	Protection of Pavement	300
Method of Measurement		
409.04.01	Measurement	302
409.04.02	Pavement Thickness	302
Basis of Payment		
409.05.01	Payment	306
SECTION 501—PORTLAND CEMENT CONCRETE		
Description		
501.01.01	General	309

CONSTRUCTION DETAILS—*Continued*

		PAGE
Materials		
501.02.01	General	309
501.02.02	Gradation Requirements	309
501.02.03	Admixtures	310
501.02.04	Concrete Making Properties	312
Construction		
501.03.01	Equipment	315
501.03.02	Protecting and Sampling Cement	315
501.03.03	Storage of Aggregates	316
501.03.04	Classifications and Proportions	316
501.03.05	Proportioning Methods	317
501.03.06	Machine Mixing	321
501.03.07	Hand Mixing	326
501.03.08	Retempering	326
501.03.09	Curing	326
501.03.10	Weather Limitations	328
Basis of Payment		
501.05.01	Payment	331

SECTION 502—CONCRETE STRUCTURES

Description		
502.01.01	General	333
Materials		
502.02.01	General	333
Construction		
502.03.01	Depth of Footings	333
502.03.02	Forms	333
502.03.03	Falsework	337
502.03.04	Reinforcement	338
502.03.05	Cofferdams and Cribs	338
502.03.06	Pumping Water	339
502.03.07	Mixing Concrete	339
502.03.08	Handling and Placing Concrete	339
502.03.09	Pumping Concrete	343
502.03.10	Concrete Deposited Under Water	343
502.03.11	Construction Joints	344
502.03.12	Removal of Falsework, Forms, and Housing	346
502.03.13	Expansion and Fixed Joints and Bearings	347
502.03.14	Curing	349
502.03.15	Patching	350
502.03.16	Finish of Horizontal Surfaces	350
502.03.17	Formed Surfaces Requiring Finishing	351
502.03.18	Ordinary Surface Finish	351
502.03.19	Fine Surface Finish	351
502.03.20	Live Loads	354

CONSTRUCTION DETAILS—*Continued*

Method of Measurement PAGE
502.04.01 Measurement ... 355

Basis of Payment
502.05.01 Payment ... 356

SECTION 503—PRECAST PRESTRESSED CONCRETE MEMBERS

Description
503.01.01 General ... 359

Materials
503.02.01 General ... 359

Construction
503.03.01 Prestressing Methods ... 359
503.03.02 Forms ... 360
503.03.03 Anchorages and Distribution ... 361
503.03.04 Enclosures ... 362
503.03.05 Prestressing ... 362
503.03.06 Curing ... 366
503.03.07 Shipping ... 367
503.03.08 Handling ... 367

Method of Measurement
503.04.01 Measurement ... 367

Basis of Payment
503.05.01 Payment ... 367

SECTION 504—LIGHTWEIGHT CONCRETE FOR STRUCTURES

Description
504.01.01 General ... 369

Materials
504.02.01 General ... 369
504.02.02 Admixtures ... 369
504.02.03 Concrete Making Properties ... 369

Construction
504.03.01 General ... 370
504.03.02 Storage of Aggregates ... 372
504.03.03 Classification and Proportions ... 372
504.03.04 Mixing ... 374

Method of Measurement
504.04.01 Measurement ... 374

Basis of Payment
504.05.01 Payment ... 375

CONSTRUCTION DETAILS—*Continued*

SECTION 505—REINFORCING STEEL

Description PAGE

505.01.01 General ... 377

Materials

505.02.01 General ... 377
505.02.02 Samples ... 377

Construction

505.03.01 Bending Diagrams ... 377
505.03.02 Protection of Materials ... 378
505.03.03 Bending ... 378
505.03.04 Placing and Fastening ... 378
505.03.05 Splicing ... 378
505.03.06 Substitutions ... 379

Method of Measurement

505.04.01 Measurement ... 379

Basis of Payment

505.05.01 Payment ... 380

SECTION 506—STEEL STRUCTURES

Description

506.01.01 General ... 381

Materials

506.02.01 General ... 381

Construction

506.03.01 Shop Drawings ... 381
506.03.02 Notice of Beginning Work ... 382
506.03.03 Inspection and Testing ... 382
506.03.04 Storage ... 384
506.03.05 Straightening ... 384
506.03.06 Rivet Holes ... 384
506.03.07 Rivets ... 386
506.03.08 Shop Riveting ... 386
506.03.09 Subpunching, Drilling, and Reaming ... 387
506.03.10 Bolts and Bolted Connections ... 387
506.03.11 Shop Assembly ... 392
506.03.12 Edge Planing ... 393
506.03.13 Facing of Bearing Surfaces ... 394
506.03.14 Abutting Joints ... 394
506.03.15 Flame Cutting ... 394
506.03.16 End Connection Angles ... 395
506.03.17 Lacing Bars ... 395
506.03.18 Web Plates ... 395
506.03.19 Stud Shear Connectors ... 396
506.03.20 Welding ... 402

CONSTRUCTION DETAILS—*Continued* PAGE

506.03.21 Fit of Stiffeners ... 402
506.03.22 Annealing and Stress Relieving ... 403
506.03.23 Pins, Rollers and Pin Holes ... 403
506.03.24 Shop Painting ... 404
506.03.25 Marking and Shipping ... 404
506.03.26 Erection Methods and Equipment ... 404
506.03.27 Falsework ... 405
506.03.28 Bearing and Anchorage ... 406
506.03.29 Field Assembling and Riveting ... 407
506.03.30 Misfits ... 408
506.03.31 Field Painting ... 408

Method of Measurement

506.04.01 Measurement ... 408

Basis of Payment

506.05.01 Payment ... 410

SECTION 507—TIMBER STRUCTURES

Description

507.01.01 General ... 411

Materials

507.02.01 General ... 411

Construction

507.03.01 Storage of Materials ... 411
507.03.02 Workmanship ... 412
507.03.03 Treated Timber ... 412
507.03.04 Untreated Timber ... 413
507.03.05 Holes for Bolts, Dowels, Rods, and Lag Screws ... 413
507.03.06 Bolts and Washers ... 413
507.03.07 Framing ... 413
507.03.08 Caps ... 414
507.03.09 Bracing ... 414
507.03.10 Stringers ... 415
507.03.11 Plank Floors ... 415
507.03.12 Laminated Floors ... 416
507.03.13 Trusses ... 416
507.03.14 Painting ... 417

Method of Measurement

507.04.01 Measurement ... 417

Basis of Payment

507.05.01 Payment ... 417

SECTION 508—PILING

Description

508.01.01 General ... 419

CONSTRUCTION DETAILS—*Continued*

		PAGE
Materials		
508.02.01	General	419
Construction		
508.03.01	Determination of Length	419
508.03.02	Test Piles	420
508.03.03	Equipment	420
508.03.04	Driving of Piles	421
508.03.05	Bearing Value and Penetration	423
508.03.06	Cutoff and Extensions	424
508.03.07	Load Testing	425
508.03.08	Timber Piles	426
508.03.09	Precast Concrete Piles	427
508.03.10	Cast-In-Place Concrete Piles	428
508.03.11	Steel Piles	430
Method of Measurement		
508.04.01	Measurement	431
Basis of Payment		
508.05.01	Payment	431
SECTION 601—PIPE CULVERTS—GENERAL		
Description		
601.01.01	General	435
Materials		
601.02.01	General	435
Construction		
601.03.01	Earthwork	436
601.03.02	Headwalls	436
601.03.03	End Sections	436
601.03.04	Jacked Pipes	437
601.03.05	Laying Culvert Pipe	437
601.03.06	Extending Existing Culverts	437
Method of Measurement		
601.04.01	Measurement	438
Basis of Payment		
601.05.01	Payment	439
SECTION 602—NON-REINFORCED CONCRETE AND CLAY PIPE		
Description		
602.01.01	General	441
Materials		
602.02.01	General	441

CONTENTS

CONSTRUCTION DETAILS—*Continued*

Construction PAGE

602.03.01 General ... 441

Method of Measurement

602.04.01 Measurement ... 442

Basis of Payment

602.05.01 Payment ... 442

SECTION 603—REINFORCED CONCRETE PIPE

Description

603.01.01 General ... 443

Materials

603.02.01 General ... 443

Construction

603.03.01 General ... 444
603.03.02 Earthwork ... 444
603.03.03 Laying Culvert Pipe ... 445
603.03.04 Rubber Gasketed Joints ... 447
603.03.05 Siphons and Pressure Pipe ... 448

Method of Measurement

603.04.01 Measurement ... 448

Basis of Payment

603.05.01 Payment ... 448

SECTION 604—CORRUGATED METAL PIPE AND METAL ARCH PIPE

Description

604.01.01 General ... 451

Materials

604.02.01 General ... 451

Construction

604.03.01 General ... 451
604.03.02 Laying Culvert Pipe ... 452
604.03.03 Siphons ... 452
604.03.04 Relay Culvert Pipes ... 453

Method of Measurement

604.04.01 Measurement ... 454

Basis of Payment

604.05.01 Payment ... 454

CONSTRUCTION DETAILS—*Continued*

SECTION 605—ALUMINUM CORRUGATED METAL PIPE AND ALUMINUM ARCH CULVERTS

Description PAGE

605.01.01 General ... 455

Materials

605.02.01 General ... 455

Construction

605.03.01 General ... 455

Method of Measurement

605.04.01 Measurement ... 455

Basis of Payment

605.05.01 Payment ... 455

SECTION 606—STRUCTURAL PLATE PIPE AND PIPE ARCH CULVERTS

Description

606.01.01 General ... 457

Materials

606.02.01 General ... 457

Construction

606.03.01 Description Plates ... 458
606.03.02 Fabrication ... 458
606.03.03 Field Inspection ... 459
606.03.04 Earthwork ... 459
606.03.05 Assembling ... 460
606.03.06 Strutting ... 461
606.03.07 Workmanship ... 461
606.03.08 Headwalls ... 462
606.03.09 Extending Existing Structural Plate Pipe and Pipe Arch Culverts ... 462

Method of Measurement

606.04.01 Measurement ... 462

Basis of Payment

606.05.01 Payment ... 463

SECTION 607—UNDERDRAINS

Description

607.01.01 General ... 465

Materials

607.02.01 General ... 465

CONSTRUCTION DETAILS—*Continued*

Construction PAGE
607.03.01 Earthwork ... 466
607.03.02 Laying Pipes ... 466
607.03.03 Underdrain Outlets ... 467

Method of Measurement
607.04.01 Measurement ... 467

Basis of Payment
607.05.01 Payment ... 467

SECTION 608—DOWNDRAINS

Description
608.01.01 General ... 469

Materials
608.02.01 General ... 469

Construction
608.03.01 Metal Downdrains ... 469
608.03.02 Bituminous Mixtures and Grouted Riprap ... 470

Method of Measurement
608.04.01 Measurement ... 470

Basis of Payment
608.05.01 Payment ... 471

SECTION 609—CATCH BASINS, MANHOLES, AND INLETS

Description
609.01.01 General ... 473

Materials
609.02.01 General ... 473

Construction
609.03.01 General ... 473
609.03.02 Adjusting Catch Basin, Manhole, and Inlet Covers ... 474
609.03.03 Clean Out ... 474
609.03.04 Earthwork ... 474

Method of Measurement
609.04.01 Measurement ... 474

Basis of Payment
609.05.01 Payment ... 475

SECTION 610—RIPRAP

Description
610.01.01 General ... 477

CONSTRUCTION DETAILS—*Continued*

		PAGE
Materials		
610.02.01	General	477
Construction		
610.03.01	Earthwork	478
610.03.02	Riprap	478
610.03.03	Heavy Riprap	479
610.03.04	Grouted Riprap	479
610.03.05	Sacked Concrete Riprap	479
Method of Measurement		
610.04.01	Measurement	480
Basis of Payment		
610.05.01	Payment	480

SECTION 611—CONCRETE SLOPE PAVING

Description		
611.01.01	General	483
Materials		
611.02.01	General	483
Construction		
611.03.01	Earthwork	483
611.03.02	General	483
Method of Measurement		
611.04.01	Measurement	484
Basis of Payment		
611.05.01	Payment	484

SECTION 612—METAL BIN-TYPE RETAINING WALLS

Description		
612.01.01	General	487
Materials		
612.02.01	General	487
Construction		
612.03.01	Fabrication	487
612.03.02	Earthwork	488
612.03.03	Assembly	488
Method of Measurement		
612.04.01	Measurement	489
Basis of Payment		
612.05.01	Payment	489

CONTENTS

CONSTRUCTION DETAILS—*Continued*

SECTION 613—CONCRETE CURBS, GUTTERS, AND SIDEWALKS

Description PAGE

613.01.01 General ... 491

Materials

613.02.01 General ... 491

Construction

613.03.01 Earthwork ... 491
613.03.02 Existing Curbs, Gutters, and Sidewalks ... 491
613.03.03 Forms ... 492
613.03.04 Curb and Gutter Joints ... 492
613.03.05 Sidewalk Expansion Joints ... 493
613.03.06 Curb and Gutter Construction ... 493
613.03.07 Sidewalk Construction ... 495

Method of Measurement

613.04.01 Measurement ... 495

Basis of Payment

613.05.01 Payment ... 496

SECTION 614—PAINTING

Description

614.01.01 General ... 497

Materials

614.02.01 General ... 497
614.02.02 Number of Coats ... 498

Construction

614.03.01 Weather Conditions ... 498
614.03.02 Application—General ... 498
614.03.03 Surface Preparation of Steel ... 499
614.03.04 Painting Structural Steel ... 501
614.03.05 Painting Timber ... 503

Basis of Payment

614.05.01 Payment ... 503

SECTION 615—PRESERVATIVE TREATMENTS FOR TIMBER

Description

615.01.01 General ... 505

Materials

615.02.01 General ... 505

Construction

615.03.01 Treatment ... 505
615.03.02 Amount of Preservative ... 505

CONSTRUCTION DETAILS—*Continued*

PAGE

615.03.03 Preservative Treatment by the Hot-Cold Soaking Method 506
615.03.04 Inspection 507

Basis of Payment

615.05.01 Payment 507

SECTION 616—FENCING

Description

616.01.01 General 509

Materials

616.02.01 General 509

Construction

616.03.01 General 509
616.03.02 Standard Fence 510
616.03.03 Chain-Link Fence 511
616.03.04 Reconstruct Fence 512
616.03.05 Gates 513

Method of Measurement

616.04.01 Measurement 513

Basis of Payment

616.05.01 Payment 514

SECTION 617—CATTLE GUARDS

Description

617.01.01 General 515

Materials

617.02.01 General 515

Construction

617.03.01 Earthwork 515
617.03.02 General 515

Method of Measurement

617.04.01 Measurement 516

Basis of Payment

617.05.01 Payment 516

SECTION 618—GUARDRAIL

Description

618.01.01 General 519

Materials

618.02.01 General 519
618.02.02 Reflectors 519

CONSTRUCTION DETAILS—*Continued*

Construction PAGE
618.03.01 General ... 520
618.03.02 Painted Guardrail ... 520
618.03.03 Galvanized Guardrail ... 521
618.03.04 Reconstructed Guardrail ... 522

Method of Measurement
618.04.01 Measurement ... 522

Basis of Payment
618.05.01 Payment ... 522

SECTION 619—CULVERT MARKERS AND GUIDE POSTS

Description
619.01.01 General ... 525

Materials
619.02.01 General ... 525

Construction
619.03.01 General ... 525
619.03.02 Reset ... 525

Method of Measurement
619.04.01 Measurement ... 525

Basis of Payment
619.05.01 Payment ... 526

SECTION 620—RIGHT OF WAY MARKERS

Description
620.01.01 General ... 527

Materials
620.02.01 General ... 527

Construction
620.03.01 General ... 527

Method of Measurement
620.04.01 Measurement ... 527

Basis of Payment
620.05.01 Payment ... 528

SECTION 621—MONUMENTS

Description
621.01.01 General ... 529

Materials
621.02.01 General ... 529

CONSTRUCTION DETAILS—*Continued*

		PAGE
Construction		
621.03.01	Installation	529
Method of Measurement		
621.04.01	Measurement	530
Basis of Payment		
621.05.01	Payment	530
SECTION 622—RAISED TRAFFIC BARS		
Description		
622.01.01	General	531
Materials		
622.02.01	General	531
Construction		
622.03.01	Installation	532
Method of Measurement		
622.04.01	Measurement	532
Basis of Payment		
622.05.01	Payment	532
SECTION 623—SIGNALS AND LIGHTING		
Description		
623.01.01	General	533
623.01.02	Regulations and Code	533
623.01.03	Equipment List and Drawings	534
623.01.04	Maintaining Existing and Temporary Electrical Systems	535
623.01.05	Scheduling of Work	536
623.01.06	Safety Precautions	537
623.01.07	Definitions	537
Materials		
623.02.01	General	539
623.02.02	Foundations	540
623.02.03	Standards, Steel Pedestals, and Posts	540
623.02.04	Conduit	543
623.02.05	Pull Boxes	543
623.02.06	Expansion Fittings	544
623.02.07	Conductors	544
623.02.08	Wood Poles	550
623.02.09	Sign Switches	550
623.02.10	Galvanizing	551
623.02.11	Signal Systems	551
Construction		
623.03.01	General	601
623.03.02	Foundations	602

CONTENTS

CONSTRUCTION DETAILS—*Continued* PAGE

623.03.03 Excavating and Backfilling ... 603
623.03.04 Removing and Replacing Improvements ... 604
623.03.05 Standards, Steel Pedestals, and Posts ... 604
623.03.06 Conduit ... 605
623.03.07 Pull Boxes ... 609
623.03.08 Wiring ... 609
623.03.09 Bonding and Grounding ... 613
623.03.10 Service ... 615
623.03.11 Field Tests ... 616
623.03.12 Painting ... 618
623.03.13 Raising or Relocating Existing Pressure-Sensitive Detectors ... 620
623.03.14 Salvaging and Reinstalling or Stockpiling Electrical Equipment ... 620

Method of Measurement

623.04.01 Measurement ... 621

Basis of Payment

623.05.01 Payment ... 622

SECTION 624—ACCOMMODATIONS FOR PUBLIC TRAFFIC

Description

624.01.01 General ... 623

Materials

624.02.01 General ... 623

Construction

624.03.01 Special Detours ... 623
624.03.02 Flagmen ... 624
624.03.03 Pilot Cars ... 625
624.03.04 Maintain Base ... 625
624.03.05 Equipment Rental ... 626

Method of Measurement

624.04.01 Measurement ... 626

Basis of Payment

624.05.01 Payment ... 626

SECTION 625—CONSTRUCTION SIGNS

Description

625.01.01 General ... 629

Materials

625.02.01 General ... 629

Construction

625.03.01 General ... 629

CONSTRUCTION DETAILS—*Continued*

Method of Measurement PAGE
625.04.01 Measurement ... 632

Basis of Payment
625.05.01 Payment ... 633

SECTION 626—TEMPORARY SIGNS

Description
626.01.01 General ... 635

Materials
626.02.01 General ... 635

Construction
626.03.01 General ... 635
626.03.02 Preparation of Sign Faces ... 636
626.03.03 Sign Background ... 636
626.03.04 Cut-out Letters, Numerals, Symbols, and Accessories ... 636
626.03.05 Installation ... 637
626.03.06 Tests ... 637
626.03.07 Remove and Re-erect Temporary Signs or Barricades ... 637

Method of Measurement
626.04.01 Measurement ... 638

Basis of Payment
626.05.01 Payment ... 638

SECTION 627—PERMANENT SIGNS

Description
627.01.01 General ... 641

Materials
627.02.01 General ... 641

Construction
627.03.01 Fabrication ... 641
627.03.02 Preparation of Sign Faces ... 643
627.03.03 Sign Background ... 645
627.03.04 Cut-out Letters, Numerals, Symbols, and Accessories ... 646
627.03.05 Installation ... 648
627.03.06 Tests ... 649

Method of Measurement
627.04.01 Measurement ... 649

Basis of Payment
627.05.01 Payment ... 649

CONTENTS

DIVISION III—MATERIALS DETAILS

SECTION 701—PORTLAND CEMENT

Scope PAGE

701.01.01 Materials Covered 651

Physical Properties and Tests

701.03.01 Requirements 651

SECTION 702—CONCRETE CURING MATERIALS AND ADMIXTURES

Scope

702.01.01 Materials Covered 653

Physical Properties and Tests

702.03.01 Curing Materials 653
702.03.02 Subgrade Paper 654
702.03.03 Air-Entraining Admixtures 654
702.03.04 Admixtures Other Than Air-Entraining 654
702.03.05 Calcium Chloride 654
702.03.06 Hydrated Lime 654

SECTION 703—BITUMINOUS MATERIALS

Scope

703.01.01 Materials Covered 655

Requirements

703.02.01 Contractor's Responsibility 655
703.02.02 Shipping Notice 655

Physical Properties and Tests

703.03.01 Refinery Test Report 656
703.03.02 Asphalt Cements 656
703.03.03 Liquid Asphalts 660
703.03.04 Emulsified Asphalt 664

SECTION 704—BASE AGGREGATES

Scope

704.01.01 Materials Covered 671

Requirements

704.02.01 General 671
704.02.02 Deficiencies 671
704.02.03 Plastic Limits 671

Physical Properties and Tests

704.03.01 Drain Backfill 672
704.03.02 Type 1 Class A Aggregate Base 672
704.03.03 Type 1 Class B Aggregate Base 673
704.03.04 Type 2 Class A Aggregate Base 673
704.03.05 Type 2 Class B Aggregate Base 673

MATERIALS DETAILS—*Continued* PAGE

704.03.06 Type 3 Class A Aggregate 674
704.03.07 Type 3 Class B Aggregate 674
704.03.08 Aggregate for Portland Cement Treated Base 674

SECTION 705—AGGREGATES FOR BITUMINOUS COURSES

Scope

705.01.01 Materials Covered 675

Requirements

705.02.01 General 675
705.02.02 Deficiencies 675

Physical Properties and Tests

705.03.01 Plantmix and Roadmix Bituminous Base and Surface Aggregate, Types 1, 2, and 3 675
705.03.02 Plantmix Surface Aggregate, Type 4 676
705.03.03 Plantmix Bituminous Open-Graded Surface Aggregate 677
705.03.04 Commercial Mineral Filler 677
705.03.05 Screenings 677
705.03.06 Sand Blotter 678

SECTION 706—AGGREGATES FOR PORTLAND CEMENT PRODUCTS

Scope

706.01.01 Materials Covered 679

Requirements

706.02.01 General 679

Physical Properties and Tests

706.03.01 Coarse Aggregate 679
706.03.02 Lightweight Aggregates 681
706.03.03 Fine Aggregate 682
706.03.04 Grout and Mortar Sand 683
706.03.05 Stone for Masonry and Riprap 684

SECTION 707—JOINT MATERIAL

Scope

707.01.01 Material Covered 685

Physical Properties and Tests

707.03.01 Joint Fillers 685
707.03.02 Rubber Gaskets 685
707.03.03 Waterstops 685

SECTION 708—CONCRETE AND CLAY PIPE AND DRAINS

Scope

708.01.01 Materials Covered 687

CONTENTS

MATERIALS DETAILS—*Continued*

Physical Properties and Tests PAGE

708.03.01 Reinforced Concrete Pipe ... 687
708.03.02 Nonreinforced Concrete Pipe ... 687
708.03.03 Perforated Concrete Pipe ... 687
708.03.04 Clay Pipe ... 687
708.03.05 Bituminous Fiber Pipe ... 687
708.03.06 Perforated Bituminous Fiber Pipe ... 688

SECTION 709—METAL PIPE AND DRAINS

Scope

709.01.01 Material Covered ... 689

Physical Properties and Tests

709.03.01 Corrugated Metal Pipe and Pipe Arches ... 689
709.03.02 Bituminous Coated Corrugated Metal Pipe and Pipe Arches ... 689
709.03.03 Corrugated Aluminum Pipe ... 690
709.03.04 Corrugated Metal Pipes for Downdrains ... 690
709.03.05 Corrugated Metal Pipe for Underdrains ... 690
709.03.06 Bituminous Coated Corrugated Metal Pipe for Underdrains ... 690
709.03.07 Corrugated Aluminum Pipe for Underdrains ... 690
709.03.08 Structural Plate Pipe and Pipe Arches ... 690

SECTION 710—STRUCTURAL AND EYEBAR STEEL

Scope

710.01.01 Material Covered ... 691

Requirements

710.02.01 Defects ... 691

Physical Properties and Tests

710.03.01 Standard Steel ... 691
710.03.02 High Strength-Low Alloy Structural Manganese Vanadium Steel ... 691
710.03.03 High Tensile Strength Bolts ... 691
710.03.04 Stainless Steel Bolts ... 691
710.03.05 Welded Seamless Steel Pipe ... 691
710.03.06 Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes ... 691
710.03.07 Shear Connector Studs ... 692
710.03.08 Pins and Rollers ... 692

SECTION 711—ALUMINUM FOR BRIDGE RAIL

Scope

711.01.01 Material Covered ... 693

MATERIALS DETAILS—*Continued*

Physical Properties and Tests PAGE

711.03.01 Aluminum Alloy for Pipe ... 693
711.03.02 Aluminum Alloy Tubing ... 693
711.03.03 Cast Aluminum Alloy ... 693
711.03.04 Aluminum Alloy Shims ... 693

SECTION 712—MISCELLANEOUS METAL

Scope

712.01.01 Material Covered ... 695

Physical Properties and Tests

712.03.01 Steel Castings ... 695
712.03.02 Gray Iron Castings ... 695
712.03.03 Malleable Castings ... 695
712.03.04 Wrought Iron Plates ... 695
712.03.05 Bronze Castings ... 695
712.03.06 Welding Materials ... 695
712.03.07 Steel Piles ... 695
712.03.08 Steel Shell for Piles ... 695

SECTION 713—REINFORCEMENT

Scope

713.01.01 Materials Covered ... 697

Physical Properties and Tests

713.03.01 Bar Steel Reinforcement ... 697
713.03.02 Fabricated Steel Bar or Rod Mats Reinforcement ... 697
713.03.03 Welded Steel Wire Fabric Reinforcement ... 697
713.03.04 Prestressing Steel ... 697

SECTION 714—PAINT

Scope

714.01.01 Materials Covered ... 701

Requirements

714.02.01 Certificates ... 701

Physical Properties and Tests

714.03.01 Iron and Steel Use Items ... 701
714.03.02 Timber Use Items ... 702
714.03.03 Concrete Use Items ... 703

SECTION 715—GALVANIZING

Scope

715.01.01 Material Covered ... 705

Physical Properties and Tests

715.03.01 Products One-eighth (⅛) Inch Thick and Thicker 705
715.03.02 Rail Elements ... 705
715.03.03 Hardware ... 705

CONTENTS

MATERIALS DETAILS—*Continued*

SECTION 716—SIGN MATERIALS

Scope PAGE

716.01.01 Materials Covered 707

Requirements

716.02.01 General 707
716.02.02 Certificates 707

Physical Properties and Tests

716.03.01 General 707

SECTION 717—TIMBER PILES

Scope

717.01.01 Materials Covered 711

Requirements

717.02.01 Certificates 711

Physical Properties and Tests

717.03.01 General 711

SECTION 718—TIMBER

Scope

718.01.01 Materials Covered 713

Requirements

718.02.01 Grades 713
718.02.02 Certificates of Inspection 713

Physical Properties and Tests

718.03.01 Species 713
718.03.02 Grades 713

SECTION 719—TIMBER PRESERVATIVES

Scope

719.01.01 Materials Covered 715

Physical Properties and Tests

719.03.01 Preservatives 715

SECTION 720—GUARDRAIL MATERIALS

Scope

720.01.01 Materials Covered 717

Requirements

720.02.01 Certificates 717

Physical Properties and Tests

720.03.01 Rail Members 717
720.03.02 Fittings 718
720.03.03 Reflector Plates 718

MATERIALS DETAILS—*Continued*

SECTION 721—CULVERT MARKERS AND GUIDE POSTS

Scope PAGE

721.01.01 Materials Covered ... 719

Requirements

721.02.01 Certificates ... 719

Physical Properties and Tests

721.03.01 Metal Posts ... 719
721.03.02 Target Plates ... 719
721.03.03 Reflectors ... 721

SECTION 722—WATER

Scope

722.01.01 Material Covered ... 723

Requirements

722.02.01 General ... 723

Physical Properties and Tests

722.03.01 Concrete Use ... 723

SECTION 723—HARDWARE

Scope

723.01.01 Materials Covered ... 725

Physical Properties and Tests

723.03.01 Galvanizing ... 725
723.03.02 Bolts, Nuts, Dowels, and Drift Bolts ... 725
723.03.03 Washers ... 725

SECTION 724—FENCE MATERIALS

Scope

724.01.01 Materials Covered ... 727

Requirements

724.02.01 Samples and Certificates of Inspection ... 727

Physical Properties and Tests

724.03.01 Wood Posts ... 727
724.03.02 Metal Posts ... 728
724.03.03 Barbed Wire ... 729
724.03.04 Woven Wire ... 729
724.03.05 Chain-Link Fabric ... 729
724.03.06 Staples, Brace Wire, and Nails ... 729
724.03.07 Metal Gates ... 729

SECTION 725—ELASTOMERIC BEARING PADS

Scope

725.01.01 Materials Covered ... 731

CONTENTS

MATERIALS DETAILS—*Continued*

Requirements PAGE

725.02.01 Certificate of Inspection 731

Physical Properties and Tests

725.03.01 General 731

SECTION 726—ROADSIDE MATERIALS

Scope

726.01.01 Materials Covered 733

Requirements

726.02.01 Certificates and Samples 733

Physical Properties and Tests

726.03.01 Top Soil 734
726.03.02 Fertilizer 735
726.03.03 Humus 735
726.03.04 Mulch 735
726.03.05 Jute Matting 736
726.03.06 Plants 736
726.03.07 Seeds 737
726.03.08 Tree Ties 737
726.03.09 Pipe and Fittings 737
726.03.10 Control Tubing 738
726.03.11 Gate Valves 738
726.03.12 Quick Coupler Valves 738
726.03.13 Masonry 738

DIVISION I

GENERAL REQUIREMENTS

SECTION 101

DEFINITIONS AND TERMS

Wherever in these specifications or in other contract documents the following terms or pronouns in place of them are used, the intent and meaning shall be interpreted as follows:

101.01 Abbreviations. Wherever the following abbreviations are used in these specifications or on the plans, they are to be construed the same as the respective expressions represented:

AAN—American Association of Nurserymen
AAR—Association of American Railroads
AASHO—American Association of State Highway Officials
ACI—American Concrete Institute
AGC—Associated General Contractors of America
AIA—American Institute of Architects
AISC—American Institute of Steel Construction
ARA—American Railway Association
AREA—American Railway Engineering Association
ASA—American Standards Association
ASCE—American Society of Civil Engineers
ASLA—American Society of Landscape Architects
ASME—American Society of Mechanical Engineers
ASTM—American Society for Testing and Materials
AWG—American Wire Gauge
AWPI—American Wood Preservers Institute
AWS—American Welding Society
AWWA—American Water Works Association
BPR—Bureau of Public Roads—Department of Transportation

Code—National Electric
EIA—Electronic Industries Association
FSS—Federal Specifications and Standards, General Services Administration.
IEEE—Institute of Electrical and Electronics Engineers
MUTCD—Manual on Uniform Traffic Control Devices for Streets and Highways. Published by the Bureau of Public Roads
NEMA—National Electrical Manufacturers Association
SAE—Society of Automotive Engineers
UL—Underwriters Laboratories, Incorporated
USASI—United States of America Standards Institute

101.02 Advertisement. The public announcement, as required by law, inviting bids for work to be performed or materials to be furnished.

101.03 Award. The acceptance by the Department of a bid.

101.04 Bidder. An individual, firm, or corporation submitting a bid for the advertised work.

101.05 Bridge. A structure, including supports, erected over a depression or an obstruction, as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads and having a length measured along the center of roadway of more than twenty (20) feet between undercopings of abutments or extreme ends of openings for multiple boxes.

Length. The length of a bridge structure is the overall length measured along the line of survey stationing back to back of backwalls of abutments, if present, otherwise end to end of the bridge floor; but in no case less than the total clear opening of the structure.

Roadway width. The clear width measured at right angles to the longitudinal centerline of the bridge between the bottom of curbs or guard timbers or in the case of

multiple height of curbs, between the bottoms of the lower risers.

101.06 Calendar Day. Every day shown on the calendar.

101.07 Contract Change Order. A written order issued by the Engineer to the Contractor, covering changes in the plans or quantities or both, within the scope of the contract and establishing the basis of payment and time adjustments for the work affected by the change.

101.08 Channel. A natural or artificial water course.

101.09 Contract. The written agreement between the Department and the Contractor setting forth the obligations of the parties thereunder, including, but not limited to the performance of the work, the furnishing of labor and materials, and the basis of payment.

The contract includes the invitation for bids, proposal, contract form and contract bond, standard specifications, supplemental specifications, special provisions, general and detailed plans, notice to proceed, and any change orders and supplemental agreements that are required to complete the construction of the work in an acceptable manner, including authorized extensions and basis of payment thereof, all of which constitute one instrument.

101.10 Contract Bond. The approved form of security, executed by the Contractor and his surety or sureties, guaranteeing complete execution of the contract and all supplemental agreements pertaining thereto and the payment of all legal debts pertaining to the construction of the project.

101.11 Contract Item (Pay Item). A specifically described item of work for which a price is provided in the contract.

101.12 Contractor. The individual, firm, or corporation contracting with the Highway Department for performance of prescribed work.

101.13 Contract Time. The number of work days or calendar days allowed for completion of the contract, including authorized time extensions.

In case a calendar date of completion is shown in the proposal in lieu of the number of working or calendar days, the contract shall be completed by that date.

101.14 Culvert. Any structure not classified as a bridge which provides an opening under the roadway.

101.15 Department. The party of the first part to a contract which shall be the State Highway Department as constituted under the laws of the State of Nevada, for the administration of highway work.

101.16 Detour. A temporary route for traffic around a closed portion of road.

101.17 Directors. The directors of the State Highway Department of the State of Nevada as established by the laws of the State of Nevada, acting directly or through their authorized representatives.

101.18 Divided Highway. A highway with separated roadways for traffic in opposite directions.

101.19 Employee. Any person working on the project mentioned in the contract of which these specifications are a part, and who is under the direction and control, or receives compensation from the Contractor or his subcontractor.

101.20 Engineer. The State Highway Engineer of the State of Nevada, acting either directly or through his duly authorized representatives, who is responsible for the engineering supervision of the construction.

101.21 Equipment. All machinery and equipment, together with the necessary supplies for upkeep and maintenance, and also tools and apparatus necessary for the proper construction and acceptable completion of the work.

101.22 Extra Work. An item of work not provided for in the contract as awarded but found essential to the satisfactory completion of the contract within its intended scope.

101.23 Frontage Road or Frontage Street. A local street or road auxiliary to and located generally on the side of an arterial highway for service to abutting property and adjacent areas and for control of access.

101.24 Highway. A general term denoting a public way for purposes of vehicular travel, including the entire area within the right of way.

101.25 Holidays. In the State of Nevada, these occur on:

New Year's Day—January 1
Memorial Day—May 30
Independence Day—July 4
Labor Day—First Monday of September
Admission Day—October 31
Veterans' Day—November 11
Thanksgiving Day—Fourth Thursday of November
Christmas Day—December 25

or on any day that may be designated by the President of the United States or the Governor of Nevada for public fast, thanksgiving, or holiday.

If any holiday listed above falls on a Sunday, the following Monday shall be considered a holiday.

101.26 Inspector. The Engineer's authorized representative assigned to make detailed inspections of contract performance.

101.27 Laboratory. The testing laboratory of the Department or any other testing laboratory which may be designated by the Engineer.

101.28 Major Contract Item. Any contract item having an original contract value of five (5) percent or more of the total original contract amount.

101.29 Materials. Any substances specified for use in the construction of the project and its appurtenances.

101.30 Median. That portion of a divided highway separating the travel ways for traffic generally in opposite directions.

101.31 Notice to Contractors. The official notice inviting bids for the proposed work.

101.32 Notice to Proceed. A written notice to the Contractor to proceed with the contract work including, when applicable, the date of beginning of contract time.

101.33 Plans. The approved plans, profiles, typical cross sections, working drawings, and supplemental drawings, or exact reproductions thereof, which show the location, character, dimensions, and details of the work to be done.

101.34 Profile Grade. The trace of a vertical plane intersecting the top surface of the proposed structural section as shown on the plans. Profile grade means either elevation or gradient of such trace according to the context.

101.35 Project. The specific section of the highway together with all appurtenances and construction to be performed thereon at the prices quoted.

101.36 Proposal. The offer of a bidder, on the prescribed form, to perform the work and to furnish the labor and materials at the prices quoted.

101.37 Proposal Form. The approved form on which the Department requires bids to be prepared and submitted for the work.

101.38 Proposal Guaranty. The security furnished with a bid to guarantee that the bidder will enter into the contract if his bid is accepted.

101.39 Right of Way. A general term denoting land, property or interest therein, usually in a strip, acquired for or devoted to a highway.

101.40 Road. A general term denoting a public way for purposes of vehicular travel, including the entire area within the right of way.

101.41 Roadbed. The graded portion of a highway within top and side slopes, prepared as a foundation for the pavement structure and shoulders.

101.42 Roadside. A general term denoting the area adjoining the outer edge of the roadway. Extensive areas between the roadways of a divided highway may also be considered roadside.

101.43 Roadside Development. Those items necessary to the complete highway which provide for the preservation of landscape materials and features; the rehabilitation and protection against erosion of all areas disturbed by construction through seeding, sodding, mulching, and the placing of other ground covers; such suitable planting and other improvements as may increase the effectiveness and enhance the appearance of the highway.

101.44 Roadway. The portion of a highway within limits of construction.

101.45 Shoulder. The portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses.

101.46 Sidewalk. That portion of the roadway primarily constructed for the use of pedestrians.

101.47 Special Provisions. Additions and revisions to the standard and supplemental specifications covering conditions peculiar to an individual project.

101.48 Specifications. The directions, provisions, and requirements contained in the Standard Specifications and supplemental specifications as modified by the special provisions. Whenever the term "these specifications" is used in this book, it means the provisions set forth in this book.

101.49 State. The State of Nevada acting through its authorized representatives.

101.50 Street. A general term denoting a public way for purposes of vehicular travel, including the entire area within the right of way.

101.51 Structures. Bridges, culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, end walls, buildings, sewers, service pipes, underdrains, foundation drains, and other features which may be encountered in the work and not otherwise classed herein.

101.52 Subcontractor. Any individual, firm, or corporation to whom the Contractor, with the consent of the Department, sublets any part of the contract.

101.53 Subgrade. The top surface of a roadbed upon which the pavement structure and shoulders are constructed.

101.54 Substructure. All of that part of the structure below the bearings of simple and continuous spans, skewbacks of arches, and tops of footings of rigid frames, together with backwall, wingwalls, and wing protection railings.

101.55 Superintendent. The Contractor's authorized representative in responsible charge of the work, present on the work at all times during the progress to supervise and direct the construction, to receive and fulfill instructions from the Engineer, and to accept orders for changed and extra work.

101.56 Superstructure. The entire structure except the substructure.

101.57 Supplemental Agreement. A written agreement made and entered into by and between the Contractor and the Department covering work not otherwise provided for, revisions in or amendments to the terms of the contract, or conditions specifically prescribed in the specifications as requiring supplemental agreements. Such supplemental agreements become a part of the contract when approved and properly executed.

101.58 Supplemental Specifications. Additions and revisions to the Standard Specifications that are adopted subsequent to the issuance of the printed book.

101.59 Surety. The corporation, partnership, or individual, other than the Contractor, executing a bond furnished by the Contractor.

101.60 Traffic Lane. The portion of a traveled way for the movement of a single line of vehicles.

101.61 Traveled Way. That portion of roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

101.62 Work. Work will mean furnishing all labor, materials, equipment, and other incidentals necessary or convenient to the successful completion of the project and the carrying out of all of the duties and obligations as imposed by the contract.

101.63 Working Day. A calendar day on which weather and other conditions not under the control of the Contractor will permit construction operations to proceed for the major part of the day (five (5) hours) with the normal working force engaged in performing the controlling item or items of work which would be in progress at that time, exclusive, however, of Saturdays, Sundays, State recognized holidays, and any day that is incumbent upon the Contractor, by means of a labor union, to observe as a holiday. However, if the Contractor elects to work on such days, those days will be considered as a working day.

Attention is directed to subsections 108.04, "Limitation

of Operations" and 108.08, "Determination and Extension of Contract Time."

101.64 Working Drawings. Stress sheets, shop drawings, erection plans, falsework plans, framework plans, cofferdam plans, bending diagrams for reinforcing steel, or any other supplementary plans or similar data which the Contractor is required to submit to the Engineer for approval.

101.65 In order to avoid cumbersome and confusing repetition of expressions in these specifications, it is provided that whenever anything is, or is to be, done, if, as, or, when, or where "contemplated, required, determined, directed, specified, authorized, ordered, given, designated, indicated, considered necessary, deemed necessary, permitted, reserved, suspended, established, approval, approved, disapproved, acceptable, unacceptable, suitable, accepted, satisfactory, unsatisfactory, sufficient, insufficient, rejected, or condemned," it shall be understood as if the expression were followed by the words "by the Engineer" or "to the Engineer."

SECTION 102

BIDDING REQUIREMENTS AND CONDITIONS

102.01 Notice to Contractors. After the date is fixed for the letting of the work, the Department will give notice of such letting to Contractors. The Notice to Contractors will contain a description of proposed work, together with information to the bidder regarding access to the proposal forms, plans, and specifications, the amount and nature of proposal guaranty, and the reservation of the right of the Department to reject any or all bids.

102.02 Prequalification of Bidders. All bidders shall be prequalified as required by law. To be qualified, a prospective bidder shall submit, under oath, on the standard form furnished by the Department, a statement of his financial ability and experience in the performance of contracts for public work. Financial statements shall be prepared and certified by a certified public accountant, or by an accountant who has been previously approved by the Department as being competent to prepare a Contractor's financial statement. After verifying the information contained in the statement, the Department shall notify the submitter of the maximum contract amount and class of work upon which he will be eligible to bid.

Statements of financial ability and experience shall be submitted as of the date upon which the fiscal year of the prospective bidder ends.

In order to remain on the qualified list, a prospective bidder shall submit a new statement at the close of his fiscal year. A prospective bidder not already qualified shall submit his statement of financial ability and experience at least five (5) full days prior to the date set for the opening of bids in which he is interested in order to have it considered, but qualification shall not be granted until such statement has been verified. Statements shall preferably be submitted at least thirty (30) days prior to bid opening.

Nothing contained in this section shall be construed as depriving the Department of its discretion in the matter of determining the lowest responsible bidder.

On Federal-aid projects, any Contractor otherwise qualified by the State of Nevada to perform such work is not required to be licensed nor to submit application for license in advance of submitting a bid or having such bid considered, provided, however, that such exception does not constitute a waiver of the State's right under its license laws to require a Contractor, determined to be a successful bidder, to be licensed to do business in the State of Nevada in connection with the award of a contract to him.

No bid will be accepted from, or contract awarded to, a Contractor to whom a proposal form has not been issued by the Department of Highways.

102.03 Contents of Proposal Forms. Upon request, the Department will furnish the prospective bidder with a proposal form. This form will state the location and description of the contemplated construction and will show the approximate estimate of the various quantities and kinds of work to be performed or materials to be furnished, and will have a schedule of items for which unit bid prices are invited. The proposal form will state the time in which the work must be completed, the amount of the proposal guaranty, and the date, time, and place of the opening of proposals. The form will also include any special provisions or requirements which vary from or are not contained in the standard specifications.

All papers bound with or attached to the proposal form are considered a part thereof and must not be detached or altered when the proposal is submitted.

The plans, specifications, and other documents designated in the proposal form, will be considered a part of the proposal whether attached or not.

The prospective bidder or interested non-bidder will be required to pay the Department the sum stated in the advertisement and "Notice to Contractors" for each copy of proposal form and each set of plans. The contract documents are nonreturnable and no refund will be made.

Checks in payment for plans and specifications will be made payable to the State of Nevada, Department of Highways.

102.04 Interpretation of Quantities in the Proposal. The quantities given in the notice to contractors and in the proposal and contract forms are approximate only, being given as a basis for the comparison of bids, and the Department does not, expressly or by implication, agree that the actual amount of work will correspond therewith, but reserves the right to increase or decrease the amount of any class or portion of the work, or to omit portions of the work, as may be deemed necessary or advisable by the Engineer.

102.05 Examination of Plans, Specifications, Contract Documents, and Site of Work. The Department will prepare plans and specifications giving such directions as will enable any competent mechanic or Contractor to carry them out. The bidder is expected to examine carefully the site of the proposed work, the proposal, plans, specifications, supplemental specifications, special provisions, and contract forms before submitting a proposal. The submission of a bid shall be considered prima facie evidence that the bidder has made such examination and is satisfied as to the conditions to be encountered in performing the work and as to the requirements of the plans, specifications, supplemental specifications, special provisions, and contract documents.

When a pay item is shown on the plans and not in the proposal, and such pay item is not specifically excluded from payment either in these specifications or in the contract documents, the pay item shall then be considered an obvious omission in the proposal and payment will be made according to the provisions of subsection 104.03, "Extra Work."

Whenever the Department has obtained subsurface information for study and design, some of which may constitute possible local materials sources, and which may be of interest to bidders, said information may be obtained upon request from the Department as "Materials Information." While such data will have been collected with reasonable care, there is no expressed or implied guaranty that conditions so indicated are exact or entirely representative of

those actually existing and the Department will in no way be responsible for the accuracy therein contained. It is expressly understood and agreed that information obtained as "Materials Information" is not a part of the contract.

Information derived from such inspection of records of investigations made by the Department will not in any way relieve the Contractor from fulfilling the terms of the contract.

When a log of test borings, showing a record of the data obtained by the Department's investigation of subsurface conditions, is included with the contract plans, said record is the Department's opinion of such borings and there is no expressed or implied guaranty that conditions so indicated are exact or entirely representative of those actually existing. Such a log is included in the plans only for information and its use is subject to all of the conditions and limitations as set forth in this section.

If a mass diagram has been prepared for a project, it will be available to the bidders upon the following conditions: The swell or shrinkage of excavated material and the direction and quantities of haul or overhaul as shown on said mass diagram are for the purpose of design only, and as in the case of "Materials Information" the Department assumes no responsibility whatever in the interpretation or exactness of any of the information shown on the mass diagram, and does not, either expressed or implied, make any guaranty of the same.

102.06 Preparation of Proposal. The bidder shall submit his proposal upon the forms furnished by the Department. The bidder shall specify a unit price in figures and words for each pay item for which a quantity is given, and shall also show the products of the respective unit prices and quantities, written in figures in the column provided for that purpose, and the total amount of the proposal obtained by adding the amount of the several items. All the words and figures shall be in ink or typed. In case of a discrepancy between the prices written in words and those written in figures, the prices written in words shall govern.

When an item in the proposal contains a choice to be

made by the bidder, the bidder shall indicate his choice in writing, in accordance with the specifications for that particular item, and thereafter no further choice will be permitted.

The bidder's proposal must be signed with ink by the individual, by one or more members of the partnership, by one or more members or officers of each firm representing a joint venture, or by one or more officers of a corporation, or by an agent of the Contractor, legally qualified and acceptable to the State. If the proposal is made by an individual, his name and post office address must be shown; by a partnership, the name and post office address of each partnership member must be shown; as a joint venture, the name and post office address of each member or officer of the firms represented by the joint venture must be shown; by a corporation, the name of the corporation and the business address of its corporate officials must be shown.

102.07 Irregular Proposals. Proposals will be considered irregular and may be rejected for the following reasons:

(a) If the proposal is on a form other than that furnished by the Department, or if the form is altered or any part thereof is detached.

(b) If there are unauthorized additions, conditional or alternate bids, or irregularities of any kind which may tend to make the proposal incomplete, indefinite, or ambiguous as to its meaning.

(c) If the bidder adds any provisions reserving the right to accept or reject an award, or to enter into a contract pursuant to an award.

This does not exclude a bid limiting the maximum gross amount of awards acceptable to any one bidder or at any one bid letting, provided that the selection of any bid awards be made by the Department.

(d) If the unit prices contained in the proposal are obviously unbalanced, either in excess or below the reasonable cost analysis values.

(e) If the proposal does not contain a unit price for each pay item listed.

102.08 Proposal Guaranty. No proposal will be considered unless accompanied by a proposal guaranty, in the amount equal to five (5) percent of the Contractor's bid, made unconditionally payable to the State Highway Department, which guaranty, at the bidder's optin, may be cash, cashier's check, certified check, postal money order, bank money order, express money order, bank draft, or any other guaranty that may be especially approved by the Department. Such proposal guaranty is to be forfeited to the Department should the bidder to whom the contract is awarded fail to enter into the contract within twenty (20) days after award.

102.09 Delivery of Proposals. Each proposal should be submitted in a special envelope furnished by the Department. The blank spaces on the envelope shall be filled in correctly to clearly indicate its contents. When an envelope other than the special one furnished by the Department is used, it shall be of the same general size and shape and be similarly marked to clearly indicate its contents. When sent by mail, the sealed proposal shall be addressed to the Department at the address and in care of the official in whose office the bids are to be received. All proposals shall be filed prior to the time and at the place specified in the advertisement and "Notice to Contractors." Proposals received after the time for opening of bids will be returned to the bidder unopened.

102.10 Withdrawal or Revision of Proposals. A bidder may withdraw or revise a proposal after it has been deposited with the Department, provided the request for such withdrawal or revision is received by the Department, in writing or by telegram, before the time set for the opening of proposals. The withdrawal of a proposal shall not prejudice the right of the bidder to file a new proposal provided it is received prior to the time set for opening of proposals.

102.11 Public Opening of Proposals. Proposals will be opened and read publicly at the time and place indicated in the advertisement and "Notice to Contractors."

Bidders, their authorized agents, and other interested parties are invited to be present.

102.12 Disqualification of Bidders. Any of the following reasons may be considered as sufficient for the disqualification of a bidder and the rejection of his proposal or proposals:

(a) More than one proposal for the same work from an individual, firm, or corporation under the same or different name.

(b) Evidence of collusion among bidders. Participants in such collusion will receive no recognition as bidders for any future work of the Department until any such participants shall have been reinstated as a qualified bidder.

(c) Unsatisfactory performance record as shown by past work for the Department judged from the standpoint of workmanship and progress.

(d) Uncompleted work which in the judgment of the Department might hinder or prevent the prompt completion of additional work if awarded.

(e) Failure to pay or satisfactorily settle all bills due for labor or material on former contracts in force at the time of letting.

(f) Failure to hold a valid license of a class corresponding to the work to be done as required by the State Contractor's License Law. However, it is not required that a Contractor have a contractor's license in order to bid on Federal-aid projects.

(g) Failure to comply with any qualification regulations of the Department.

102.13 Material Guaranty. The successful bidder may be required to furnish a complete statement of the origin, composition, and manufacture of any or all materials to be used in the construction of the work together with samples, which samples may be subject to the tests provided for in these specifications to determine their quality and fitness for the work.

102.14 Combination or Conditional Bids. On certain projects a bidder may submit bids on more work than

he desires to have awarded to him. He may indicate the total amount he desires to accept and the Department will determine which of his low bids on these projects, up to the final total indicated, will be accepted. This limitation will only apply to those projects on which the following statement has been included in the proposal and is properly filled in by the Contractor.

"We desire to disqualify all of our bids at this letting which exceed the total of $..... or ..... contracts and hereby authorize the Department to determine which bids shall be disqualified."

"A proposal guaranty, conforming to subsection 102.-08, "Proposal Guaranty," in the amount of $..... accompanies the proposal for project number ..... or has been filed with the Department in advance."

Contractor

102.15 Motor Fuel Tax Refund. It is understood and agreed that the price bid by the Contractor for the work to be done under the contract shall include the applicable tax on motor vehicle fuel and special fuel as required by Chapters 365 and 366 of the Nevada Revised Statutes.

It shall be the Contractor's responsibility to determine that subcontractors have reported fuel consumption to the Nevada Tax Commission as required by law.

SECTION 103

AWARD AND EXECUTION OF CONTRACT

103.01 Consideration of Proposals. After the proposals are opened and read, they will be compared on the basis of the summation of the products of the approximate quantities shown in the bid schedule by the unit bid prices. The results of such comparisons will be immediately available to the public. In the event of a discrepancy between unit bid prices and extensions, the unit bid prices shall govern.

The right is reserved to reject any or all proposals, to waive technicalities, or to advertise for new proposals, if in the judgment of the awarding authority, the best interests of the Department will be promoted thereby.

103.02 Award of Contract. The Department shall require from each bidder before award of contract, a sworn statement, executed by, or on behalf of, the person, firm, association, or corporation to whom such a contract is to be awarded, certifying that such persons, firm, association, or corporation has not, either directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken any action in restraint of free competitive bidding in connection with such contract.

The award of the contract, if it be awarded, will be to the lowest responsible bidder whose proposal complies with all the requirements prescribed. The award, if made, will be made within thirty (30) calendar days after the opening of the proposals. The successful bidder will be notified by letter, mailed to the address shown on his proposal, that his proposal has been accepted and that he has been awarded the contract.

The date of the award of the contract shall be the date of the "Notice of Award."

103.03 Cancellation of Award. The Department reserves the right to cancel the award of any contract at any

time before the execution of said contract by all parties without any liability against the Department.

Whenever a contract is awarded to an unlicensed Contractor, it shall be with the full understanding that such award shall become null and void should said Contractor fail to become licensed, in accordance with the provisions of NRS Chapter 624 for any reason within the control of said Contractor, within twenty (20) calendar days after award of said contract.

103.04 Return of Proposal Guaranty. All proposal guaranties, except those of the three lowest bidders will be returned immediately following the opening and checking of the proposals. The retained proposal guaranty of the unsuccessful of the three lowest bidders will be returned within ten (10) days following the award of the contract and that of the successful bidder will be returned after a satisfactory bond has been furnished and the contract has been executed.

103.05 Requirement of Contract Bond. The successful bidder shall, at the time of the execution of the contract, furnish a surety bond or bonds in a sum equal to the full amount of the contract as a guaranty that he will complete the work in accordance with the terms of the contract. Such bond, or bonds, shall also provide and secure payment for all materials, labor and supplies, trucks, and other means of transportation, used in, or upon, or about, or for the performance of the work contracted to be done, and for any work or labor done thereupon or incidental thereto. The bond or bonds shall be on the form provided in the proposal and shall be written by a surety approved by the Insurance Commissioner of the State of Nevada. A power of attorney for an attorney in fact who executes bonds shall be registered with, and approved by, the Insurance Commissioner of the State of Nevada. The power of attorney shall show the limiting amount authorized for issuance of bonds. Written appointment of agent of bonding company in and for the State of Nevada shall also be registered with, and approved by, the Insurance Commissioner.

103.06 Execution and Approval of Contract. The contract shall be signed by the successful bidder and returned, together with the contract bond, within twenty (20) calendar days after the contract has been mailed to the bidder. If the contract is not executed by the Department within thirty (30) calendar days following receipt from the bidder of the signed contract and bond, the bidder shall have the right to withdraw his bid without penalty. No contract shall be considered as effective until it has been fully executed by all the parties thereto.

103.07 Failure to Execute Contract. Failure to execute the contract and file acceptable bonds and/or failure to obtain a valid contractor's license within twenty (20) calendar days after the contract has been awarded shall be just cause for the annulment of the award and the forfeiture of the proposal guaranty which shall become the property of the Department, not as a penalty, but as liquidation of damages sustained. Award may then be made as provided in subsection 103.02, "Award of Contract," or the work may be readvertised and constructed under contract or otherwise, as the Department may decide.

SECTION 104

SCOPE OF THE WORK

104.01 Intent of the Contract. The intent of the contract is to provide for the construction and completion in every detail of the work described. The Contractor shall furnish all labor, materials, equipment, tools, transportation, and supplies required to complete the work in accordance with the plans, specifications, and terms of the contract.

104.02 Increased or Decreased Quantities and Change in Character of Work. The Engineer reserves the right to make by written order and without notice to surety, such alterations in the plans or character or quantity of the work which may be considered necessary or desirable from time to time during the progress of the work to complete satisfactorily the proposed construction. Such alterations shall not be considered as a waiver of any conditions of the contract or invalidate any of the provisions thereof.

Whenever an alteration in character of work involves a substantial change in the nature of the design or in the type or extent of construction which materially increased or decreases the cost of the performance, the work shall be performed in accordance with the specifications and as directed, provided however, that before such work is started, a supplemental agreement acceptable to both parties to the contract shall be executed.

The right is reserved to increase or decrease any or all of the items in the estimate of approximate quantities as shown in the proposal. The length of the project may be increased or decreased by adding or omitting sections or by relocation. Under no circumstances shall alterations of plans or of the nature of the work involve work beyond the termini of the proposed construction except as may be necessary to satisfactorily complete the project.

If it is found that the quantity of any major item required to complete the work underruns or overruns less

than twenty-five (25) percent of the proposal quantity, payment for the work performed will be made at the contract unit price for the quantity of work actually performed.

Whenever the termini of the project are changed and whenever any change or combination of changes results in increasing or decreasing the original contract amount as calculated from the bid quantities and contract unit prices by more than twenty-five (25) percent, a supplemental agreement acceptable to both parties to the contract shall be executed in advance of performing the affected work.

Whenever an overrun or underrun of more than twenty-five (25) percent of the original bid quantity for one or more major contract items occurs, either party to the contract may demand a supplemental agreement to be negotiated satisfactory to both parties.

Revision of any unit price requested by the Contractor shall be negotiated on the basis of actual cost plus a reasonable allowance for profit and overhead. Written request for supplemental agreement shall set forth in detail the particulars and character by which the work was changed and by what amount the unit price of the proposal item will be altered. Failure of the Contractor to file a request for a supplemental agreement within ten (10) calendar days after any of the above outlined conditions are encountered shall be considered as a waiver thereof on the part of the Contractor and payment shall be made at the contract unit price for the actual quantity of work performed.

If a supplemental agreement satisfactory to both parties cannot be agreed upon, the Engineer may order the work in dispute to be performed on a force account basis or he may cancel the work from the contract.

Changes not requiring negotiated agreements, except as to extra work involved, shall be ordered by means of a contract change order, and acceptance by the Contractor, as evidenced by his signature, shall constitute agreement that the change does not involve any adjustment of contract unit prices. Attention is directed to subsection

108.08, "Determination and Extension of Contract Time." Work shall not be started on any such change until the change order has been delivered to the Contractor and accepted by him.

In case the Contractor refuses to accept a change order, the Engineer may order the work to proceed and defer settlement of the disputed points.

104.03 Extra Work. The Contractor shall perform unforeseen work, for which there is no price included in the contract, whenever it is deemed necessary or desirable in order to complete fully the work as contemplated. Such work shall be performed in accordance with the specifications and as directed, and will be paid for as agreed unit prices, force account, or a combination of the two. Agreed unit prices together with the estimated quantities of each unit shall be shown. Orders involving extra and force account work shall be as detailed in subsection 109.03, "Extra and Force Account Work," and conform to the requirements contained therein.

104.04 Maintenance of Traffic. While undergoing improvements, the road shall be kept open to all traffic by the Contractor unless otherwise provided for in the contract documents. If the usable roadway is not sufficient to safely accommodate two-way traffic, the Contractor shall adequately maintain one-way traffic. Wherever one-way traffic is in effect, the distance shall not be in excess of six thousand (6,000) feet or as otherwise set forth in writing by the Engineer. Where controlled traffic is necessary for protection of the work or for the safety of public travel, it shall be in accordance with the provisions of subsections 624.03.02, "Flagmen" and 624.03.03, "Pilot Cars" of these specifications. The Contractor shall also provide and maintain in a safe condition, temporary approaches or crossings and intersections with trails, roads, streets, businesses, parking lots, residences, garages, and farms. Snow removal, however, will not be required of the Contractor. The Contractor shall bear all expense of maintaining the roadway over the section of road undergoing improvement

and of constructing and maintaining such approaches, crossings, intersections, and other features as may be necessary, without direct compensation, except as provided in subsection 107.15, "Relief from Maintenance and Responsibility," or in (a) or (b) below:

(a) Special detours and maintain base. When the proposal contains an item for "Special Detours" or "Maintain Base," the Contractor will be paid on a "Force Account" basis for the construction and maintenance of the detour(s) and the maintenance of the roadway base. Attention is directed to Section 624, "Accommodations for Public Traffic."

(b) Maintenance of traffic during suspension of work. The Contractor shall be responsible for the maintenance of the roadway during suspension of the work when such suspensions are due to the Contractor's negligence. Attention is directed to subsection 108.06, "Temporary Suspension of the Work." During any other suspension, the Contractor shall make passable and shall open to traffic such portions of the project and temporary roadways or portions thereof as may be agreed upon between the Contractor and the Engineer for the temporary accommodation of traffic during the anticipated period of suspension. Thereafter, and until an issuance of an order for the resumption of construction operations, the maintenance of the temporary route or line of travel agreed upon will be by and at the expense of the Department. Such maintenance and responsibility will include and be restricted to: the traveled roadway for the convenience of public travel; opening plugged pipes and roadway ditches and drains or correcting any other hazard which may be detrimental to adjacent property owners or the traveling public. When work is resumed, it shall be the Contractor's responsibility to replace, renew, and repair any work or materials lost or damaged because of such temporary use of the project regardless of the cause of such damage or loss, except as provided in subsection 107.15, "Relief of Maintenance and Responsibility." It is herewith expressed that the Department is in no way responsible to the Contractor to maintain the roadway

and appurtenances in any certain condition or state of repair. It is incumbent upon the Contractor to complete the project in every respect as though its prosecution had been continuous and without interference.

Where construction of a project is staged in the plans, or otherwise outlined by the contract documents, and if a change in the staging or sequence of operations is desirable, the Contractor may submit such change in writing to the Engineer. Consideration will be given to each such proposal and may be rejected, modified or accepted by the Engineer as he deems best. The Contractor will not proceed with any such change in the staging until permission is granted by the Engineer in writing.

When detours, temporary connections, crossovers, connection roads, and frontage roads are constructed by the item "Equipment Hours," such item shall be full compensation for excavating, hauling, overhaul, and compacting of the material complete and in place and for all labor involved to complete the detour. Base and surface courses will be paid for at the contract unit price for the particular type of material required. All of the above mentioned roadways will be constructed to the same standards and qualities and subject to the same tests and specifications as the main roadway. Attention is directed to Section 624, "Accommodations for Public Traffic."

When a detour is requested by the Contractor he shall make a written request to the Engineer for the establishment of a detour around all or certain designated sections of work. If arrangements for such a detour can be made which are satisfactory to the State, to the Contractor, and to the governmental agency having jurisdiction over the road to be used, the Engineer will designate that road as a detour, subject to the following conditions:

(a) The Contractor shall provide and maintain the necessary route marking signs.

(b) The Contractor shall construct and maintain in good condition such a detour. If the Contractor fails to maintain the detour in such a condition satisfactory to the Engineer,

the State will make such repairs as is deemed suitable and will deduct the cost thereof from money due or to become due to the Contractor.

(c) Provisions for handling traffic will be subject to the conditions of subsections 624.03.02, "Flagmen" and 624.-03.03, "Pilot Cars" of these standard specifications.

(d) Upon abandoning the detour, the Contractor shall obliterate and dispose of such detour and restore as nearly as possible the condition of the ground to its original form and to the satisfaction of the Engineer.

(e) All of the above work will be at the sole expense of the Contractor.

104.05 Rights in and Use of Materials Found on the Work. The Contractor, with the approval of the Engineer, may use on the project such stone, gravel, sand, or other material determined suitable by the Engineer, as may be found in the excavation and will be paid for both the excavation of such materials at the corresponding contract unit price and also at the contract unit price for the pay item for which the excavated material is used. He shall replace at his own expense with other acceptable material all of that portion of the excavation material so removed and used which was needed for use in the embankments, backfills, approaches, or otherwise. No charge for the materials so used will be made against the Contractor. The Contractor shall not excavate or remove any material from within the highway location which is not within the grading limits, as indicated by the slope and grade lines, without written authorization from the Engineer.

Unless otherwise provided, the material from any existing old structure may be used temporarily by the Contractor in the erection of the new structure. Such material shall not be cut or otherwise damaged except with the approval of the Engineer.

104.06 Final Clean Up. Before final acceptance, the Contractor shall remove or obliterate, insofar as feasible, all objects or disturbances of the ground which mar the landscape and were caused by his operations, whether or not part of the improvement. This shall be required on all

areas used or occupied by the Contractor within or outside the right of way limits.

Rubbish, excess material, temporary structures, and discarded equipment shall be collected and burned, buried or otherwise disposed of as directed by the Engineer. Pits or trenches for equipment set-ups or camp sites shall be filled and the ground restored, insofar as feasible, to its original conditions, within or outside of the right of way limits. Temporary haul roads within the right of way limits shall be scarified and bladed to blend with surroundings. Pits from which materials have been obtained shall be dressed and shaped to conform with the surrounding ground. Waste shall be removed from the tops of banks and placed in the bottom of pit. Unless otherwise specified or directed by the Engineer, banks of pits shall be cut to not steeper than two to one (2:1) slopes to blend with the natural contours. Bottoms of pits shall be reasonably smooth. All other disturbances shall be removed or corrected as directed by the Engineer.

SECTION 105

CONTROL OF WORK

105.01 Authority of the Engineer. The Engineer will decide all questions which may arise as to the quality and acceptability of materials furnished and work performed and as to the rate of progress of the work; all questions which may arise as to the interpretation of the plans and specifications; all questions as to the acceptable fulfillment of the contract on the part of the Contractor.

The Engineer will have the authority to suspend the work wholly or in part due to the failure of the Contractor to correct conditions unsafe for the workmen or the general public; for failure to carry out the provisions of the contract; for failure to carry out orders; for such periods as he may deem necessary due to unsuitable weather; for conditions considered unsuitable for the prosecution of the work or for any other condition or reason deemed to be in the public interest.

Whenever the Contractor fails to carry out orders of the Engineer, the Engineer will have executive authority to enforce such orders and his decision will be final. In the event the Contractor fails to execute work ordered by the Engineer within a reasonable period of time, the Engineer may, after giving notice in writing to the Contractor, proceed to have such work performed as deemed necessary and the cost thereof shall be deducted from compensation due or which may become due the Contractor on the contract.

Decisions of the Engineer shall be subject to appeal to the Board of Directors, whose decisions shall be final and conclusive. Such appeal shall be in writing and shall be made within ten (10) calendar days, but in the meantime the Contractor shall diligently proceed with the work.

105.02 Plans and Working Drawings. Plans will show details of all structures, lines, grades, typical cross sections of the roadway, location and design of all structures, and a summary of items appearing on the proposal.

The Contractor will keep one set of plans available on the work at all times.

The plans will be supplemented by such working drawings as are necessary to adequately control the work. Working drawings for structures shall be furnished by the Contractor. They shall include stress sheets, shop drawings, erection plans, fabrication sheets, falsework plans, cofferdam plans, bending diagrams for reinforcing steel, or any other supplementary plans or similar data required by the Engineer. Unless otherwise specified, all working drawings must be submitted in triplicate ten (10) days prior to start of related work and approved by the Engineer. Such approval shall not operate to relieve the Contractor of any of his responsibility under the contract for the successful completion of the work. It is mutually agreed that the Contractor shall be responsible for agreement of dimensions and details as well as for conformity of his working drawings with the approved plans and specifications.

The contract price will include the cost of furnishing all working drawings.

105.03 Conformity with Plans and Specifications. All work performed and all materials furnished shall be in reasonably close conformity with the lines, grades, cross sections, dimensions, and materials requirements, including tolerances, shown on the plans or indicated in the specifications.

In the event the Engineer finds the materials or the finished product in which the materials are used not within reasonably close conformity with the plans and specifications but that reasonably acceptable work has been produced, he shall then make a determination if the work shall be accepted and remain in place. In this event, the Engineer will document the basis of acceptance by contract modification which will provide for an appropriate adjustment in the contract price for such work or materials as he deems necessary to conform to his determination based on engineering judgment.

In the event the Engineer finds the materials or the finished product in which the materials are used or the work performed are not in reasonably close conformity

with the plans and specifications and have resulted in an inferior or unsatisfactory product, the work or materials shall be removed and replaced or otherwise corrected by and at the expense of the Contractor.

105.04 Coordination of Plans, Specifications, Supplemental Specifications, and Special Provisions. The specifications, supplemental specifications, plans, special provisions, and all supplementary documents are essential parts of the contract, and a requirement occurring in one is as binding as though occurring in all. They are intended to be complementary and to describe and provide for a complete work. In case of discrepancy, calculated dimensions will govern over scale dimensions; plans will govern over specifications; supplemental specifications will govern over specifications; special provisions will govern over both specifications and plans.

The Contractor shall take no advantage of any apparent error or omission in the plans or specifications. In the event the Contractor discovers such an error or omission, he shall immediately notify the Engineer. The Engineer will then make such corrections and interpretations as may be deemed necessary for fulfilling the intent of the plans and specifications.

105.05 Cooperation by Contractor. The Contractor will be supplied with a minimum of four (4) sets of approved plans and contract assemblies including special provisions, one set of which the Contractor shall keep available on the work at all times. Additional copies of plans and special provisions may be obtained by the Contractor upon written request to the Department.

The Contractor shall give the work constant attention necessary to facilitate the progress thereof, and shall cooperate with the Engineer, his inspectors, and other contractors in every way possible.

The Contractor shall have on the work at all times, as his agent, a competent superintendent capable of reading and thoroughly understanding the plans and specifications and thoroughly experienced in the type of work being performed, who shall receive instructions from the Engineer

or his authorized representatives. Such superintendent shall be designated in writing before starting work. The superintendent shall have full authority to execute orders or directions of the Engineer without delay, and to promptly supply such materials, equipment, tools, labor, and incidentals as may be required. Such superintendence shall be furnished irrespective of the amount of work sublet.

105.06 Cooperation with Utilities. The Department will notify all utility companies, all pipeline owners, or other parties affected, and endeavor to have all necessary adjustments of the public or private utility fixtures, pipelines, and other appurtenances within or adjacent to the limits of construction, made as soon as practicable.

Water lines, gas lines, wire lines, service connections, water and gas meter boxes, water and gas valve boxes, light standards, cable ways, signals, and all other utility appurtenances within the limits of the proposed construction which are to be relocated or adjusted are to be moved by the owners at their expense, except as otherwise provided for in the special provisions or as noted on the plans.

Attention is directed to the possible existence of underground facilities not known to the State or in a location different from that which is shown on the plans or in the special provisions. The Contractor shall take steps to ascertain the exact location of all underground facilities prior to doing work that may damage such facilities or interfere with their service.

Where it is determined by the Engineer that the rearrangement of an underground facility, the existence of which is not shown on the plans or in the special provisions, is essential in order to accommodate the highway improvement, the Engineer will provide for the rearrangement of such facility by other forces or such rearrangement shall be performed by the Contractor and will be paid for as extra work as provided in subsection 104.03, "Extra Work."

Any delays to the Contractor's operations as a direct result of utility or other non-highway facilities not being

rearranged as herein provided (other than delays in connection with rearrangements made to facilitate his construction operations) will be considered right of way delays within the meaning of subsection 108.12, "Right of Way Delays."

Compensation for such delay will be determined in accordance with subsection 108.12, "Right of Way Delays" and no further compensation will be allowed therefor. Attention is directed to subsection 107.17, "Contractor's Responsibility for Utility Property and Service."

105.07 Cooperation Between Contractors. The Department reserves the right at any time to contract for and perform other or additional work on or near the work covered by the contract.

When separate contracts are let within the limits of any one project, each Contractor shall conduct his work so as not to interfere with or hinder the progress or completion of the work being performed by other Contractors. Contractors working on the same project shall cooperate with each other as directed.

Each Contractor involved shall assume all liability, financial or otherwise, in connection with his contract and shall protect and save harmless the Department from any and all damages or claims that may arise because of inconvenience, delay or loss experienced by him because of the presence and operations of other contractors working within the limits of the same project.

The Contractor shall arrange his work and shall place and dispose of the materials being used so as not to interfere with the operations of other contractors within the limits of the same project. He shall join his work with that of the others in an acceptable manner and shall perform it in proper sequence to that of the others.

105.08 Construction Stakes, Lines and Grades. The Engineer will set construction stakes establishing lines, slopes, and continuous profile-grade in road work, and centerline and bench marks for bridge work, culvert work, protective and accessory structures and appurtenances as

he may deem necessary, and will furnish the Contractor with all necessary information relating to lines, slopes, and grades. These stakes and marks shall constitute the field control by and in accordance with which the Contractor shall establish other necessary controls and perform the work.

The Contractor shall be held responsible for the preservation of all stakes and marks, and if any of the construction stakes or marks have been carelessly or willfully destroyed or disturbed by the Contractor, the cost of replacing them will be charged against him and will be deducted from the payment for the work.

The Department will be responsible for the accuracy of lines, slopes, grades, and other engineering work which is set forth under this section.

105.09 Authority and Duties of the Resident Engineer. As the direct representative of the State Highway Engineer, the resident engineer has immediate charge of the engineering details of each construction project. He is responsible for the administration and satisfactory completion of the project. The resident engineer shall have the authority to reject defective materials and to suspend any work that is being improperly performed.

105.10 Duties of the Inspector. Inspectors employed by the Department will be authorized to inspect all work done and all materials furnished. Such inspection may extend to all or any part of the work and to the preparation, fabrication, or manufacture of the materials to be used. The inspector will not be authorized to alter or waive the provisions of the contract. The inspector will not be authorized to issue instructions contrary to the plans and specifications, or to act as foreman for the Contractor.

105.11 Inspection. All materials and each part or detail of the work shall be subject to inspection by the Engineer. The Engineer shall be provided acceptable access to all parts of the work and shall be furnished with such information and assistance by the Contractor as required to make a complete and detailed inspection.

If the Engineer requests it, the Contractor, at any time before acceptance of the work, shall remove or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the work to the standard required by the specifications. Should the work thus exposed or examined prove acceptable, the uncovering, or removing and the replaceing of the covering, or making good of the parts removed will be paid for as extra work; but should the work so exposed or examined prove unacceptable, the uncovering, or removing and replacing of the covering, or making good of the parts removed will be at the Contractor's expense.

Any work done or materials used without inspection by an authorized Department representative may be ordered removed and replaced at the Contractor's expense unless the Department representative failed to inspect after having been given reasonable notice in writing that the work was to be performed.

When facilities of any unit of government or political subdivision or of any railroad corporation or public utility corporation are adjusted or constructed as a part of the work covered by this contract, its respective representatives shall have the right to inspect the work. Such inspection shall in no sense make any unit of government or political subdivision or any railroad corporation or public utility corporation a party to this contract, and shall in no way interfere with the rights of either party thereunder.

105.12 Removal of Unacceptable and Unauthorized Work. All work which does not conform to the requirements of the contract will be considered as unacceptable work, unless otherwise determined acceptable under the provisions in subsection 105.03, "Conformity with Plans and Specifications."

Unacceptable work, whether the result of poor workmanship, use of defective materials, damage through carelessness, or any other cause, found to exist prior to the final acceptance of the work, shall be removed immediately and replaced in an acceptable manner.

Work done contrary to the instructions of the Engineer,

work done beyond the lines shown on the plans, or as given, except as herein specified, or any extra work done without authority, will be considered as unauthorized and will not be paid for under the provisions of the contract. Work so done may be ordered removed or replaced at the Contractor's expense.

Upon failure on the part of the Contractor to comply forthwith with any order of the Engineer, made under the provisions of this article, the Engineer will have authority to cause unacceptable work to be remedied or removed and replaced and unauthorized work to be removed and to withhold the costs from any money due or to become due the Contractor.

105.13 Load and Speed Restrictions. The Contractor shall be responsible for all damage to the work caused by his hauling equipment.

In hauling material for incorporation in portions of highways under construction or reconstruction, hereinafter called the project, loads which are in excess of the limits set by the Department will not be permitted on any existing bridge or new and existing bituminous base and surface, cement treated base, or portland cement concrete paving which is to remain in place for vehicular traffic within the project or between the project and the pits or other sources of materials. Load limits established by the Department for the project shall be complied with regardless of the source of materials, whether from described pits, approved pits or commercial sources. Unless otherwise stated in the special provisions, the maximum loads shall not exceed the limits set forth in the Nevada Revised Statutes 484.530 et seq. and all acts amendatory thereto or supplementary thereof.

Construction loads greater than legal loads may be carried over any new bridge structure within the project providing the Contractor complies with all of the following limitations and provisions:

(a) Concrete in any such structure must have attained designed strength as shown on the structure plans.

(b) The gross load of the vehicle shall not exceed 108,000 pounds.

(c) Gross load on any individual axle shall not exceed 48,000 pounds.

(d) The gross load on any individual set of tandem axles spaced not more than six (6) feet apart shall not exceed 72,000 pounds.

(e) The center to center spacing of individual axles or center to center spacing of pairs of tandem axles shall not be less than fourteen (14) feet.

(f) No more than one lane of vehicles shall operate over any structure.

(g) The speed of any vehicle approaching or traveling on any structure shall not exceed ten (10) mph.

(h) The roadway surface approaching any structure shall be kept smooth and uniformly graded for one hundred fifty (150) feet each side of the structure and shall be maintained to provide a uniform transition onto the structure.

(i) A cover of at least six (6) inches shall be placed and maintained on the decks of all structures. Cover material shall not include rocks of diameter greater than three (3) inches.

Construction loads greater than legal loads may be carried over structures within the project which have spans of ten (10) feet to twenty (20) feet only when the Contractor complies with the above items, letters (c) to (i), inclusive; however, the limitations as set forth in paragraphs (c) to (e), inclusive, may be waived by the Engineer for reinforced concrete box structures which are adequately supported by shoring. The Contractor shall submit his proposed shoring details and the actual loads and axle spacings to the Engineer for review prior to the planned hauling. Approval will be based on a review of the shoring details and a physical inspection of the shoring complete and in place.

The Engineer shall make sufficient checks to satisfy himself that the Contractor is complying with all limitations,

and any violation shall result in denying the Contractor use of the structure until the violation has been corrected to the satisfaction of the Engineer.

The provision that the Contractor may haul construction loads greater than legal loads on new structures shall not relieve the Contractor of his responsibility for all damage caused by his hauling equipment.

The Engineer may, for the protection of the traveling public, establish speed limits on or adjacent to the project. Such limitations of speed shall be strictly observed by the Contractor.

105.14 Maintenance During Construction. The Contractor shall maintain the work during construction and until the project is accepted, except as provided for in subsections 104.04, "Maintenance of Traffic," and 107.15, "Relief from Maintenance and Responsibility." This maintenance shall constitute continuous and effective work prosecuted day by day, with adequate equipment and forces to the end that the roadway and structures are at all times, to be kept in a condition satisfactory to the Engineer.

In the case of a contract for the placing of a course upon a course or subgrade previously constructed, the Contractor shall maintain the previous course or subgrade during all construction operations.

Except as provided for in subsections 104.04, "Maintenance of Traffic," and 107.15, "Relief from Maintenance and Responsibility," all costs of maintenance work during construction and before the project is accepted shall be included in the unit prices bid on the various pay items and the Contractor will not be paid an additional amount for such work.

105.15 Failure to Maintain Roadway or Structure. If the Contractor, at any time, fails to comply with the provisions of subsection 105.14, "Maintenance During Construction," the Engineer will immediately notify the Contractor in writing of such noncompliance. If the Contractor fails to remedy unsatisfactory maintenance within

twenty-four (24) hours after receipt of such notice, the Engineer may immediately proceed to maintain the project, and the entire cost of this maintenance will be deducted from money due or to become due the Contractor.

105.16 Final Acceptance. Upon due notice from the Contractor of presumptive completion of the entire project, the Engineer will make an inspection and if all construction and final cleanup provided for and contemplated by the contract is found completed to his satisfaction, that inspection shall constitute the final inspection and the Engineer will make the final acceptance and notify the Contractor in writing of this acceptance as of the date of final inspection. Attention is directed to subsection 104.06, "Final Cleanup."

If however, the inspection discloses any work, in whole or in part, as being unsatisfactory, the Engineer will give the Contractor the necessary instructions for correction of same, and the Contractor shall immediately comply with and execute such instructions. Upon correction of the work another inspection will be made which shall constitute the final inspection provided the work has been satisfactorily completed. In such event, the Engineer will make the final acceptance and notify the Contractor in writing of this acceptance as of the date of final inspection.

105.17 Claims for Adjustment and Disputes. If, in any case, the Contractor deems that additional compensation is due him for work or material not clearly covered in the contract or not ordered by the Engineer as extra work as defined herein, the Contractor shall notify the Engineer in writing of his intention to make claim for such additional compensation before he begins the work on which he bases the claim. If such notification is not given, and the Engineer is not afforded proper facilities by the Contractor for keeping strict account of actual cost as required, then the Contractor hereby agrees to waive any claim for such additional compensation. Such notice by the Contractor, and the fact that the Engineer has kept account of the cost as aforesaid, shall not in any way be

construed as proving or substantiating the validity of the claim. If the claim, after consideration by the Engineer, is found to be just, it will be paid as extra work as provided herein for "Force Account" work. Nothing in this subsection shall be construed as establishing any claim contrary to the terms of subsection 104.02, "Increased or Decreased Quantities and Change in Character of Work."

SECTION 106

CONTROL OF MATERIAL

106.01 Source of Supply and Quality Requirements. The Contractor shall furnish all materials required to complete the work, except materials that are designated in the special provisions to be furnished by the State as specified in subsection 106.11, "Department Furnished Materials."

Only materials conforming to the requirements of the specifications shall be incorporated in the work.

The materials furnished and used shall be new, except as may be provided elsewhere in these specifications, on the plans or in the special provisions. The materials shall be manufactured, handled, and used in a workmanlike manner to ensure completed work in accordance with the plans and specifications.

The Contractor shall furnish the Engineer a list of his sources of materials. The list shall be submitted on a State-furnished form and shall be furnished to the Engineer in sufficient time to permit proper inspecting and testing of materials to be furnished from such listed sources in advance of their use.

If it is found after trial that sources of supply for previously approved materials do not produce uniform and satisfactory products, or if the product from any source proves unacceptable at any time, the Contractor shall furnish satisfactory materials from other sources.

The Contractor shall furnish without charge such samples as may be required. Inspection and tests will be made by the Engineer or his designated representative, but it is understood that such inspections and tests, if made at any point other than the point of incorporation in the work, in no way shall be considered as a guarantee of acceptance of such material nor of continued acceptance of material presumed to be similar to that upon which inspections and tests have been made.

Manufacturer's warranties, guarantees, instruction sheets, and parts lists, which are furnished with certain articles

or materials incorporated in the work, shall be delivered to the Engineer before acceptance of the contract.

Reports and records of inspections made and tests performed when available at the site of the work may be examined by the Contractor.

106.02 Local Materials. Local material is rock, sand, gravel, earth, or other mineral material, other than local borrow or selected material, obtained or produced from sources in the vicinity of the work specifically for use on the project. Local material does not include materials obtained from established commercial sources.

Local materials shall be furnished by the Contractor from any source the Contractor may elect, except when a mandatory source is designated in the special provisions.

The furnishing of local materials from any source is subject to the provisions of subsections 102.05, "Examination of Plans, Specifications, Contract Documents, and Site of Work," and 106.03, "Possible Local Material Sources." Material deposits shall not be excavated at locations where their resulting scars will present an unsightly appearance from any highway, unless such deposit is approved in writing by the Engineer. Generally, deposits located within one thousand (1,000) feet of the right of way limits will not be approved.

The Contractor shall, at his own expense, make any and all arrangements necessary for hauling over local, public or private roads or property from any source. Full compensation for furnishing all labor, materials, tools, equipment, and incidentals, for doing all the work involved in conforming to the provisions in this subsection and for furnishing and producing materials from any source shall be considered as included in the price paid for the contract item of work involving such material and no additional compensation will be allowed therefor.

106.03 Possible Local Material Sources. If the Contractor desires to use materials from sources other than those described in the "Materials Information," as referred to in subsection 102.05, "Examination of Plans, Specifications, Contract Documents, and Site of Work," he shall, at

his own expense, acquire the necessary right to take material and pay all costs involved, including any which may result from an increase in length of haul. All costs of exploring and developing such alternate sources shall be borne by the Contractor and the use of material from such sources will not be permitted until representative samples taken by the Engineer have been approved and written authority issued for the use thereof.

Where the Department has made arrangements with owners of land in the vicinity of a project for obtaining material from an owner's property, such arrangements are made solely for the purpose of providing all bidders an equal opportunity to obtain material from such property. Bidders or contractors may, upon written request, inspect the documents evidencing such arrangements between property owners and the Department. The Contractor may, if he so elects, exercise any rights that have been obtained, which may be exercised by a Contractor under such arrangements, subject to and upon the conditions hereinafter set forth.

Such arrangements are not a part of the contract and it is expressly understood and agreed that the Department assumes no responsibility to the bidder or Contractor whatsoever in respect to the Department's arrangements made with the property owner to obtain materials therefrom and that the Contractor shall assume all risks in connection with the use of such property, the terms upon which such use shall be made, and there is no warranty or guarantee, either expressed or implied, as to the quality or quantity of materials that can be obtained or produced from such property or the type or extent of processing that may be required in order to produce material conforming to the requirements of the specifications.

In those instances in which the Department has compiled "Materials Information" as referred to in subsection 102.05, "Examination of Plans, Specifications, Contract Documents and Site of Work," said compilation may include the documents setting forth the arrangements made with some of the property owners for obtaining material from such owners' properties. The inclusion of such documents therein shall not in any respect operate as a waiver

of any of the provisions in this section concerning said documents.

The bidder or Contractor is cautioned to make such independent investigation and examination as he deems necessary to satisfy himself as to the quality and quantity of materials available from such property, the type and extent of processing that may be required in order to produce material conforming to the requirements of the specifications and the rights, duties, and obligations acquired or undertaken under such an arrangement with the property owner.

Notwithstanding that the Contractor may elect to obtain materials from any such property owner's property, no material may be obtained from such property unless the Contractor has first either:

(a) Executed a document that will guarantee to hold such owner harmless from all claims for injury to persons or damage to property resulting from the Contractor's operations on the property owner's premises and also agree to conform to all other provisions set forth in the arrangement made between the Department and the property owner. Said document will be prepared by the Engineer for execution by the Contractor, or

(b) Entered into an agreement with the owner of the material source on any terms mutually agreeable to the owner and the Contractor, provided that the Contractor shall furnish to the Engineer a release, in a form satisfactory to the Engineer, executed by the owner, relieving the Department of any and all obligations under the Department's arrangement with the owner.

If the Contractor elects to obtain material under (a), the use of such site shall be subject to the terms, conditions and limitations of the arrangement made between the property owner and the Department and the Contractor shall pay such charges as are provided for in the arrangement made by the Department with the property owner.

If the Contractor elects to obtain material under (b), he shall pay such charges as are provided for in the agreement between the owner and the Contractor.

Unless otherwise provided and before acceptance of the contract, the Contractor shall submit written evidence that the owner of the material source is satisfied that the Contractor has satisfactorily complied with the provisions of either (a), the arrangement between the Department and the owner, or (b), the agreement between the owner and the contractor as the case may be.

Where the State has obtained the right to remove materials from lands owned or controlled by the U.S. Government, by withdrawal or otherwise, and these areas are set forth in the "Materials Information" for the project, the successful bidder on the project may enter and remove materials for use on subject project only, without further permission. The Contractor may not enter on or remove materials from any other areas withdrawn or otherwise obtained by the Department from the U.S. Government which is not set forth in the "Materials Information" for the project without prior written approval from the Department.

Should the Contractor enter upon any of the areas withdrawn or otherwise obtained by the Department from the U.S. Government, it shall be his responsibility to determine the rights of others in the area. The Contractor shall not encroach on easements of others without their written permission and shall assume the responsibility for any damages due to his entering said area. In addition, the Contractor shall be bound by the terms, conditions, and reservations contained in the approved application for withdrawal.

Full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in furnishing and producing specified materials from possible local material sources, including the construction of any access roads or fences and any clearing, grubbing and stripping of material sources, and all processing of whatever nature and extent required, shall be considered as included in the price paid for the contract item of work involving such material and no additional compensation will be allowed therefor.

106.04 Samples and Tests. Except as provided in subsection 106.05, "Certificates of Compliance," all materials will be inspected, tested, and accepted by the Engineer before incorporation in the work. Any work in which untested and unaccepted materials are used without approval or written permission of the Engineer shall be performed at the Contractor's risk and may be considered as unacceptable and unauthorized and will not be paid for.

It is the intent of these specifications that the Contractor shall produce materials at the plant that conform in all respects to the requirements of the specifications; however, blending on the roadbed to correct for minor deficiencies in grading, sand equivalent, or excess plasticity will be allowed under the following conditions:

(a) All blending material added on roadway and all work involved in processing such material will be at the expense of the Contractor.

(b) Processing of the material will continue until a homogeneous mixture is obtained. Uniform gradation shall be obtained to the degree that sieve analysis tests show less than ten (10) percent difference, plus or minus, in the amount of material passing the No. 16 sieve, determined by comparing sieve analysis tests on two samples of processed and blended material. Samples for tests, taken for the above conditions, shall be confined within a distance of five hundred (500) feet of each other and also taken in the same continuous windrow.

When the Contractor requests progress samples taken at the crushing plant, the plant shall be provided with a mechanical means for obtaining samples. Samples of the finished product of the plant shall be obtained prior to or as the material leaves the conveyor belt for the bin or stockpile. The sampling device shall be so constructed that small representative samples may be taken frequently and these small samples combined to form the complete sample. The samples shall be delivered by mechanical means to a point on the ground or other safe and accessible spot satisfactory to the Engineer. Test results run from samples taken will be furnished to the Contractor's representative

at his request. The results of such tests shall not be the basis for final acceptance of the material.

Sampling for final acceptance of materials will be as hereinafter outlined:

(a) Types 1, 2, and 3, Class B aggregate base courses and "Selected Material Base or Surface" will be sampled just prior to final laydown.

(b) Types 1, 2, and 3, Class A aggregate base courses will be sampled from the roadbed directly behind the laydown machine and prior to the first pass of the roller.

(c) Aggregate for cement or lime treated bases will be sampled as follows:

1. Where the material is being mixed at a stationary plant, samples will be taken from the conveyors just prior to delivery to the mixer and prior to adding lime and cement.

2. Where material is being mixed on the roadbed, samples will be taken after the material has been placed on the roadbed and processed and prior to adding cement or lime.

(d) Aggregates for roadmix bituminous mixtures (including base or surface) will be sampled after the material has been placed on the roadbed and processed and prior to adding the bituminous binder.

(e) Aggregate for plantmix bituminous open-graded will be sampled from the laydown machine.

(f) Aggregate for screenings will be sampled from the loaded truck just prior to placing.

(g) Aggregate for plantmix bituminous mixtures (base or surface) will be sampled for acceptance behind the paver. Samples for plasticity tests will be taken at the bins.

(h) Sampling of bituminous materials, intended for use in prime, tack or seal coats, surface treatments, and base, binder, or surface course mixtures, shall be done after the bituminous material has arrived at job destination and before, or at the time of unloading the materials.

Two samples shall be taken from each railroad tank car or truck transport of material by the Contractor or his designated representative under the observation of and in

a manner approved by the Engineer. Where delivery is made in smaller hauling units than those cited above such as a distributor, or where the contents of a storage tank are sampled, the required two samples shall be taken to represent a maximum of ten thousand (10,000) gallons. The Contractor shall take the samples during the established job working hours, unless arrangements are made for a representative of the Department to witness the taking of the samples at another time.

Sampling shall be done by one of the following three methods:

1. In accordance with the provisions of Test Method No. Nev. T723;
2. By bleeding through a drain-cock in the transfer line during the unloading of the approximate middle third of the load; or
3. By means of a sampling device inserted to a level of approximately the middle third of the load or tank.

The selection of the method of sampling to be used, shall be at the option of the Contractor. Where sampling is done by bleeding, five (5) to ten (10) minutes shall elapse between the separate samplings.

It shall be understood and agreed that samples obtained by any one of the above designated methods are presented and accepted by the Contractor, and accepted by the Engineer, as being truly representative of the material delivered for incorporation in the work.

All sampling devices and sample containers will be furnished by the Department. Immediately after filling the sample container, it shall be tightly sealed, properly marked for identification, and presented to the Engineer.

One of the two samples, taken from each load, shall be submitted to the Department's laboratory for testing and the other sample retained by the Resident Engineer to be later submitted to the laboratory for confirming tests in the event the first sample tested should fail to comply with requirements. If the first sample tested complies with requirements, the second sample may be discarded.

(i) Tests for the aforementioned materials produced

under conditions other than contemplated herein shall be taken at the time and place deemed by the Engineer to be most appropriate.

106.05 Certificates of Compliance. The Engineer may permit the use of certain materials or assemblies prior to sampling and testing if accompanied by a Certificate of Compliance stating that the materials involved comply in all respects with the requirements of the specifications. The certificates shall be signed by the manufacturer of the material or the manufacturer of assembled materials. A Certificate of Compliance must be furnished with each lot of material delivered to the work and the lot so certified must be clearly identified in the certificate.

All materials used on the basis of a Certificate of Compliance may be sampled and tested at any time. The fact that material is used on the basis of a Certificate of Compliance shall not relieve the Contractor of responsibility for incorporating material in the work which conforms to the requirements of the plans and specifications and any such material not conforming to such requirements will be subject to rejection whether in place or not.

The Department reserves the right to refuse to permit the use of material on the basis of a Certificate of Compliance.

The form of the Certificate of Compliance and its disposition shall be as directed by the Engineer.

106.06 Cited Specifications. Unless otherwise specified, all tests shall be performed in accordance with the methods used by the Department of Highways. All tests that are performed shall be made by the Engineer or his designated representative.

The Department of Highways has developed test methods for testing the quality of materials and work. These test methods are identified by the prefix Nev. followed by the serial number. Copies of individual test methods are available at the Materials and Research Division, Department of Highways, Carson City, Nevada, and will be furnished to interested persons upon request.

Whenever a reference is made in the specifications to a test method by Nev. number, it shall mean the test method in effect on the date of advertisement for bid.

Whenever a reference is made in the specifications to a specification or test designation either of the American Society for Testing and Materials, the American Association of State Highway Officials, federal specifications, or any other recognized national organization, and the number or other identification accompanying the test designation representing the year of adoption or latest revision of the test is omitted, it shall mean the test method in effect on the date of advertisement for bid.

When requested by the Engineer, the Contractor shall furnish, without charge, samples of all materials entering into the work, and no material shall be used prior to approval by the Engineer, except as provided in subsection 106.05, "Certificates of Compliance." Samples of material from local sources shall be taken by or in the presence of the Engineer; otherwise, the samples will not be considered for testing.

106.07 Plant Inspection. The Engineer may inspect the production of material or the manufacture of products at the source of supply. Plant inspection, however, will not be undertaken until the Engineer is assured of the cooperation and assistance of both the Contractor and the material producer. The Engineer or his authorized representative shall have free entry at all times to such parts of the plant as concerns the manufacture or production of the materials. Adequate facilities shall be furnished free of charge to make the necessary inspection.

It is understood that the Department reserves the right to retest all materials prior to incorporation into the work which have been tested and accepted at the source of supply after the same have been delivered and to reject all materials which, when retested, do not meet the requirements of these specifications, or the requirements of the contract documents.

106.08 Storage of Materials. Materials shall be so stored as to assure the preservation of their quality and

fitness for the work. When considered necessary by the Engineer, they shall be stored in waterproof buildings, placed on wooden platforms or other hard, clean surfaces, and not on the ground, and shall be covered when directed. Stored materials, even though approved for use before storage, may be inspected prior to their use in the work, and they shall meet the requirements of the specifications at the time of this proposed use. Stored materials shall be located so as to facilitate their prompt inspection. Upon approval of the Engineer, that portion of the right of way not required for public travel may be used for storage purposes and for placing of the Contractor's plant and equipment, but any additional space required therefor must be provided by the Contractor at his expense. Private or public property shall not be used for storage purposes without written permission of the owner or lessee. All storage sites shall be restored to their original condition by the Contractor at his expense. This shall not apply to the stripping and storing of top soil or to other material salvaged from the work or specifically prescribed under the specifications.

106.09 Handling Materials. All materials shall be handled in such manner as to preserve their quality and fitness for the work. Aggregates shall be transported from the storage site to the work in tight vehicles so constructed as to prevent loss or segregation of materials after loading and measuring in order that there may be no inconsistencies in the quantities of materials intended for incorporation in the work as loaded, and the quantities as actually received at the place of operation.

106.10 Unacceptable Materials. All materials not substantially conforming to the requirements of the specifications at the time they are used shall be considered as unacceptable and all such materials will be rejected and shall be removed immediately from the site of the work unless otherwise instructed by the Engineer. No rejected material, the defects of which have been corrected, shall be used until approval has been given by the Engineer.

106.11 Department Furnished Material. The Contractor shall furnish all materials required to complete the work, except those specified to be furnished by the Department. Material furnished by the Department will be delivered or made available to the Contractor at the points specified in the special provisions.

The cost of handling and placing all materials after they are delivered to the Contractor shall be considered as included in the contract price for the item in connection with which they are used.

The Contractor will be held responsible for all material delivered to him, and deductions will be made from any money due him to make good any shortages and deficiencies, from any cause whatsoever, and for any damage which may occur after such delivery and for any demurrage charges.

SECTION 107

LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

107.01 Laws To Be Observed. The Contractor shall keep fully informed of all federal and state laws, all local bylaws, ordinances, and regulations, and all orders and decrees of bodies or tribunals having jurisdiction or authority, which in any manner affect those engaged or employed on the work, or which in any way affect the conduct of the work. He shall at all times observe and comply with all such laws, bylaws, ordinances, regulations, orders, and decrees, and shall protect and indemnify the State and its representatives against any claim or liability arising from or based on the violation of any such law, bylaws, ordinances, regulations, orders, or decrees, whether by himself or his employees.

107.02 Permits, Licenses, and Taxes. The Contractor shall procure all permits and licenses, pay all charges and fees, and give all notices necessary and incident to the due and lawful prosecution of the work, including vehicular registration or prorate registration and carrier licensing as applicable. Privilege taxes are in addition to the above fees. Contractors having vehicles not licensed or registered in Nevada shall contact the Motor Carrier Division of the Motor Vehicle Department, Carson City, Nevada, for full information.

107.03 Patented Devices, Materials, and Processes. If the Contractor employs any design, device, material, or process covered by letters of patent or copyright, he shall provide for such use by suitable legal agreement with the patentee or owner. The Contractor and the surety shall indemnify and save harmless the State, any affected third party, or political subdivision from any and all claims for infringement by reason of the use of any such patented design, device, material or process, or any trademark or copyright, and shall indemnify the State for any costs,

expenses, and damages which it may be obliged to pay by reason of any infringement, at any time during the prosecution or after the completion of the work.

107.04 Restoration of Surfaces Opened by Permit. The right to construct or reconstruct any utility service in the highway or street, or to grant permits for same, at any time, is hereby expressly reserved by the Department for the proper authorities of the municipality or other political subdivision in which the work is done and the Contractor shall not be entitled to any damages either for the digging up of the street or for any delay occasioned thereby.

Any individual, firm, or corporation wishing to make an opening in the highway must secure a permit from the Department. The Contractor shall allow parties bearing such permits, and only those parties, to make openings in the highways. The Contractor shall, when ordered by the Engineer, make in an acceptable manner, all necessary repairs due to such openings, and such necessary work will be paid for as extra work, or as provided in these specifications, and will be subject to the same conditions as original work performed.

107.05 Federal Aid Provisions. (a) Work Subject to Inspection and Approval of Federal Agency. When the United States Government pays all or any portion of the cost of the work, the Federal laws authorizing such participation and the rules and regulations made pursuant to such laws, must be observed by the Contractor. The work shall be subject to the inspection of the authorized representatives of such Federal agencies as are created for the administration of these laws, but such inspection will in no sense make the Federal Government a party to the contract and will in no way interfere with the right of either party hereunder.

(b) Fair Labor Standards Act. The attention of bidders is directed to the fact that this Department has been advised by the Wage and Hour Division, U.S. Department of Labor, that contractors or subcontractors engaged in

highway construction work are required to meet the provisions of the Fair Labor Standards Act of 1938 (52 Stat. 1060) or as amended.

107.06 Sanitary Provisions. The Contractor shall provide and maintain in a neat, sanitary condition, such accommodations for the use of his employees as may be necessary to comply with the requirements and regulations of the State Department of Health and of other bodies or tribunals having jurisdiction thereover. He shall commit no public nuisance.

107.07 Public Convenience and Safety. The Contractor shall at all times conduct the work in such a manner as will obstruct and inconvenience traffic as little as possible. The Contractor shall keep existing travel roads and streets adjacent to or within the limits of the improvement, open to and in a good and safe condition for traffic at all times. The Contractor shall maintain said roads and streets to the extent that he shall be responsible for the removal of any material or debris resulting from or caused by his operations and shall repair any damage which may result from his operations. For those roads and streets actually under physical improvement, attention is directed to subsection 104.04, "Maintenance of Traffic." Where grading operations are on or adjacent to the existing traveled way, the grade should be finished immediately after the rough grading is completed and the surfacing material shall be placed thereon as the work progresses. The Contractor shall so conduct his operations as to have under construction no greater length or amount of work than he can prosecute vigorously and he shall not open up sections of the work and leave them unfinished, but he shall finish the work as he goes insofar as practicable.

The Contractor shall perform his work in a manner to assure full compliance with all applicable Federal, State, and local laws and regulations governing safety, health, and sanitation. He shall provide adequate safeguards, safety devices, and protective equipment such as

are specified in other sections of these standard specifications, or other documents and take any other needed actions as the Engineer may determine reasonably necessary to protect the life and health of employees on the job and the safety of the public and to protect property in connection with the performance of the work covered by the Contract.

The Contractor shall at all times during the progress of the work or temporary suspension of the work, provide, erect, and maintain all necessary barricades, suitable and sufficient red lights, danger signals and signs, provide a sufficient number of flagmen and take all necessary precautions for the protection of the work and safety of the public, and those engaged on the work. All barricades and obstructions shall be illuminated at night with reflectorized signs and lights, and all lights for this purpose shall be kept burning from sunset to sunrise. All barricades, warning signs, lights, temporary signals, and other protective devices must conform with the M.U.T.C.D. Manual.

107.08 Relations with Railroads. (a) Definitions. The following definitions shall apply to the terms as herein used. *Railroad:* The railway or railroad company whose tracks are crossed or whose property is adjacent to the work or upon whose property the work is performed. *Chief Engineer:* The Chief Engineer of the railroad or his authorized representatives. *Railroad Crossing:* A crossing at grade of the tracks of a railroad and the highway. *Grade Separation:* A permanent structure to affect the separation of grades between the highway and the railroad.

(b) Work or Operations.

1. Work or operations on grade separations, railroad crossings, or upon railroad property shall be subject to inspection by the Chief Engineer, and shall be conducted and performed in a manner satisfactory to the Chief Engineer.

2. Construction operations shall be so arranged and conducted as to insure safe and uninterrupted operation of the railroad traffic. The Contractor shall be responsible for any damages which result either directly or indirectly from the Contractor's operations.

3. The Contractor shall notify the Chief Engineer in writing, at least forty-eight (48) hours before starting any work in the proximity of the tracks, setting forth specifically the time at which it is planned to start such work.

4. Unless otherwise provided, the Contractor shall not pile or store any material, or park or use Contractor's equipment closer than ten (10) feet from the centerline of the tracks.

5. The track zone shall be kept clean of all loose material or debris at all times. The Contractor shall be responsible for any fouling of railroad ballast resulting from sandblasting and painting operations and shall reimburse the railroad for the replacement of all ballast so fouled.

6. In advance of any blasting, the Contractor shall notify the Chief Engineer in order that proper flagging protection may be provided by the railroad. Excavations in the proximity of the tracks shall be sheeted in a manner satisfactory to the Chief Engineer and plans therefor shall be submitted to and approved by him before any such excavation is commenced.

7. The Contractor shall make arrangements with the railroad for crossing railroad tracks at locations other than existing public crossings and shall bear all costs relative thereto.

8. The Contractor shall submit detail plans of falsework and of forms for track spans and piers or abutments to the Chief Engineer and no work thereon shall be commenced unless and until such plans have been approved by the Chief Engineer. Falsework plans thus approved shall not be deviated from without permission of the Chief Engineer. The temporary vertical and horizontal clearances specified by the Chief Engineer in approving the plans shall be maintained at all times. In the case of impaired vertical clearances above the top of rail, the railroad shall have the option to install telltales, or other such protective devices the railroad deems necessary, for the protection of trainmen or rail traffic.

9. The Contractor shall comply with the rules and regulations of the railroad with respect to the Contractor's

work or operations on or adjacent to railroad property. The Contractor shall arrange with the railroad for the services of such qualified railroad employees as the Chief Engineer may prescribe to protect and safeguard the railroad's property, engines, trains, and cars. The costs incurred for the services of such railroad employees as may be prescribed by the Chief Engineer for necessary safeguard and protection and the costs of installing telltales or other protective devices in the case of impaired vertical clearance, shall be borne by the Contractor without expense to the Department or railroad. Payment for such services, including compensation, insurance, vacation and holiday time, railroad retirement and unemployment taxes, health and welfare, accounting and billing charges, shall be paid by the Department directly to the railroad and the amount thereof shall be deducted by the Department from money due or which may become due the Contractor under the awarded contract. Rates of pay for qualified railroad employees will be the railroad's rates for the various classes of labor customarily used and in effect at the time the work is performed. The Contractor's reimbursement for personnel and protective devices required as set forth herein shall be considered as included in the contract unit prices bid for other items of work.

10. Upon completion of the work covered by the awarded contract to be performed by the Contractor upon railroad's property, the Contractor shall promptly remove from the railroad's property all tools, equipment, and other materials, whether brought upon said property by the Contractor or any subcontractor, and shall cause said property to be left in a clean and presentable condition.

(c) Work or Operations Performed by Railroad. The railroad may undertake certain work or operations incident to the project which are the subject of an agreement between the Department and railroad. Details of such work or operations will be set forth in the special provisions and the Contractor shall discuss such items with the Chief Engineer in order to develop a plan whereby the Contractor and the railroad accomplish the work or operations in their logical sequence and order.

Movement or adjustment of telephone, telegraph, or

signal facilities owned, operated, or maintained by the railroad and not otherwise provided for on the plans or in the special provisions shall be at the cost and expense of the Contractor.

(d) Insurance. The Contractor shall provide and maintain during the effective life of the awarded contract such special or additional insurance as is required by subsection 107.11, "Responsibility for Damage Claims" herein. The Contractor shall furnish such evidence as may be required that such insurance has been provided.

(e) Qualification. As a prerequisite to award, the Contractor shall be satisfactory as to responsibility to perform work upon the railroad's property.

(f) Reference. The provisions of subsections 624.03.02, "Flagmen" and 624.03.03, "Pilot Cars," subsection 107.11, "Responsibility for Damage Claims" and the special provisions shall inure directly to the benefit of the railroad.

107.09 Liability Insurance. (a) Contractor's Public Liability and Property Damage Liability Insurance. The Contractor shall provide and maintain during the effective life of the awarded contract, regular Contractor's Public Liability and Property Damage Liability Insurance to protect the Contractor and all of the Contractor's construction subcontractors for claims for personal injury, accidental death, and to property, which may arise from operations under said contract, whether such operations be by the Contractor or by such subcontractor or by anyone directly or indirectly employed by either of them.

Whenever construction operations covered under said contract are to be performed upon or in proximity to railroad property, the Contractor's Public Liability and Property Damage Insurance shall provide for limits of coverage not less than specified in the Railroad Protective Insurance Endorsement appended to the special provisions.

(b) Railroad's Protective Public Liability and Property Damage Insurance. In all cases where construction operations covered by the awarded contract are to be performed upon or adjacent to the property of the railroad, the Contractor shall furnish evidence to the Department

that, with respect to the operations the Contractor or any of the Contractor's subcontractors perform, the Contractor has provided for and in favor of the railroad a policy of Public Liability and Property Damage Insurance, to which is attached an endorsement, in the same form and with the same limits of coverage as the Railroad Protective Insurance Endorsement appended to the special provisions.

(c) General. The insurance required under paragraph (b) above shall apply only to that portion of the highway project upon or adjacent to the railroad property.

Railroad's Protective Public Liability and Property Damage Insurance shall be subject to approval by the railroad before any work is commenced on or adjacent to the railroad property.

Such insurance shall be carried, and the premiums therefor paid, by the Contractor until all work required to be performed under the terms of said contract is satisfactorily completed as evidenced by the formal acceptance of the Department and thereafter until all of said tools, equipment, and materials have been removed from the property of the railroad and such property left in a clean and presentable condition. The insurance shall be noncancelable and non-alterable for any cause whatsoever (including failure to pay premiums) either by the Contractor or by the insurance company without thirty (30) days' written notice to the railroad and the Department. In the event such insurance is canceled as herein provided, the Contractor shall provide other insurance, subject to the same conditions as provided herein, which shall be effective as of the day of such cancellation and cover the unexpired period of the term herein required. The Contractor shall furnish the Department at the time of execution of said contract, three copies of each policy to which is attached an endorsement the same as the Railroad Protective Insurance Endorsement appended to the special provisions. Two (2) copies of each of such policies shall be forwarded by the Department to the Chief Engineer for the railroad's approval.

107.10 Explosives. When the use of explosives is necessary for the prosecution of the work, the Contractor

shall exercise the utmost care not to endanger life or property, including new work. The Contractor shall be responsible for all damage resulting from the use of explosives.

All explosives shall be stored in a secure manner in compliance with all laws and ordinances, and all such storage places shall be clearly marked. Where no local laws or ordinances apply, storage shall be provided satisfactory to the Engineer and in general not closer than one thousand (1,000) feet from the road or from any building or camping area or place of human occupancy.

The Contractor shall notify each public utility company having structures in proximity to the site of the work of his intention to use explosives. Such notice shall be given sufficiently in advance to enable the companies to take such steps as they may deem necessary to protect their property from injury.

107.11 Responsibility for Damage Claims. The Contractor shall indemnify and save harmless the Department, its officers and employees, from all suits, actions, or claims of any character brought because of any injuries or damage received or sustained by any person, persons, or property on account of the operations of the said Contractor; or on account of or in consequence of any neglect in safeguarding the work; or through use of unacceptable materials in constructing the work; or because of any claims or amount recovered under the "Workman's Compensation Act," or any other law, ordinance, order, or decree; and so much of the money due the said Contractor under and by virtue of his contract as may be considered necessary by the Department for such purpose, may be retained for the use of State; or in case no money is due, his surety may be held until such suit or suits, action or actions, claim or claims for the injuries or damages as aforesaid shall have been settled and suitable evidence to that effect furnished to the Department; except that money due the Contractor will not be withheld when the Contractor produces satisfactory evidence that he is adequately protected by public liability and property damage insurance.

Reimbursement to the Contractor by the State in whole

or in part for costs of protecting traffic shall not serve to relieve the Contractor of his responsibility as set forth in these standard specifications.

The Contractor guarantees the payment of all just claims for materials, supplies, and labor, and all other just claims against him or any subcontractor, in connection with this contract.

107.12 Protection and Restoration of Property and Landscape. The Contractor shall be responsible for the preservation from injury or damage resulting directly or indirectly from the work under his contract of all public and private property, crops, trees, vegetation, monuments, fences, highway signs and markers, etc., along and adjacent to the highway, and shall use every precaution necessary to prevent damage to pipes, conduits, and other underground structures, to poles, wires, cables, and other overhead structures, whether shown on the plans or not, shall protect carefully from disturbance or damage all land monuments and property marks until the Engineer has witnessed or otherwise referenced their location, and shall not remove them until directed. The Contractor shall not willfully or maliciously injure or destroy trees or shrubs and he shall not remove or cut them without proper authority.

He shall be responsible for all damage or injury to property of any character during the prosecution of the work resulting from any act, omission, neglect, or misconduct in his manner or method of executing said work, or at any time due to defective work or materials, and such responsibility shall not be released until the project shall have been completed and accepted.

The Contractor shall be responsible for the preservation of archeological and paleontological objects, including all ruins, sites, buildings, artifacts, fossils, or other objects of antiquity encountered during construction. When such objects are encountered, the Contractor shall immediately cease operations and notify the Engineer that such objects exist. Construction operations shall be rescheduled to avoid

the section until the removal of the artifacts or the gathering of historical data has been accomplished by the appropriate authority. When directed by the Engineer, the Contractor shall excavate the site in such a manner as to preserve the artifacts encountered and shall remove them for delivery to the custody of the proper authorities. Such excavation will be considered and paid for in accordance with subsection 104.03, "Extra Work."

Extension of contract time will be allowed for any delay to the Contractor due to preservation of archeological and paleontological objects.

When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect or misconduct in the execution of the work, or in consequence of the non-execution thereof on part of the Contractor, he shall restore at his expense such property to a condition similar or equal to that existing before such damage or injury was done by repairing, rebuilding, or otherwise restoring as may be directed, or he shall make good such damage or injury in an acceptable manner. In case of failure on the part of the Contractor to restore such property or make good such damage or injury, the Engineer may, upon forty-eight (48) hours' written notice, proceed to repair, rebuild or otherwise restore such property as may be deemed necessary and the cost thereof shall be deducted from any money due, or which may become due the Contractor under the contract.

The Contractor shall restrict the movement of his vehicles and other construction equipment and personnel to the construction area and designated roads. Every precaution shall be taken to prevent the marking of the natural ground with equipment tracks or other means outside of the slope stake areas on either side of the roadway and in median areas where it is not required to disturb the existing ground. Where such markings of the natural ground are caused either by the Contractor's equipment, personnel, or operations, the Contractor, at his own expense, shall eradicate such marks to the satisfaction of the Engineer.

All roads from flat bottom ditches and material deposits shall be spaced at least one thousand (1,000) feet apart, except that such roads may also be located in ditch and dike areas. When roads are located in ditch and dike areas, equipment shall not be allowed to travel outside the area to be occupied by said ditch or dike, except as provided for in subsection 203.03.12, "Channels." The crossing of median areas shall be at structures or areas approved by the Engineer.

Where there is a high potential for erosion and subsequent water pollution, the area of erosive land that may be exposed by construction operations at any one time shall be held to a minimum, and the duration of the exposure of the uncompleted construction to the elements shall be as short as practicable. Erosion control features shall be constructed concurrently with other work and at the earliest practicable time.

Disturbance of the lands and of waters that are outside the limits of the construction as staked is prohibited, except as may be found necessary and approved by the Engineer.

107.13 Forest Protection. Before setting any fires whatsoever, the Contractor shall notify the responsible Federal, State, or other agency having jurisdiction for the area concerned. All burning shall be done at night unless otherwise authorized in writing by the Engineer. The Contractor shall abide by such rules and instructions as to fire prevention and control and as to the place for burning as the authorized representative of the appropriate agency having jurisdiction may prescribe. The Contractor shall take all necessary steps to prevent his employees from setting fires not required in the construction of the project and shall, under the direction of the appropriate Federal, State, or other agency, or, in the absence of an officer from any such agency, acting independently, extinguish all fires set or caused by his employees and all other fires which may escape on the project, whether or not set directly or indirectly as a result of construction operations, without expense to the State or federal government. Where

the Contractor is obligated to suppress any fire, without expense to the State or federal government, and if the amount of labor, subsistence, supplies, and transportation which he furnishes is inadequate in the opinion of the jurisdictional agency, then such agency may procure additional help or facilities and charge the expenses to the Contractor. These expenses shall be billed to the Contractor for payment directly by him, and if not promptly met by him shall be deducted from the money due or which may become due the Contractor under this contract, or collected from his sureties until the entire amount due for said fire suppression is recovered.

The Contractor shall maintain a fire patrol in the vicinity of blasting and other operations creating a fire hazard. When, in the opinion of the agency having jurisdiction, such a patrol is unnecessary because of weather conditions, the Contractor shall be so notified through the Engineer.

The resident engineer shall have authority to enforce correction of any condition which is, in his opinion, unsafe.

107.14 Disposal of Material Outside Highway Right of Way. The Contractor shall make his own arrangements for disposal of materials outside the highway right of way and he shall pay all costs involved.

When any material is to be disposed of outside the highway right of way, the Contractor shall first obtain a written permit from the property owner on whose property the disposal is to be made and he shall file with the Engineer said permit or the certified copy thereof together with a written release from the property owner absolving the State of any and all responsibility in connection with the disposal of material on said property. Before any material is disposed of on said property, the Contractor shall obtain written permission from the Engineer to dispose of the material at the location designated in the said permit.

When material is disposed of as above provided and the disposal location is visible from the highway, the Contractor shall dispose of the material in a neat and uniform manner to the satisfaction of the Engineer.

Unless otherwise provided in the special provisions, full

compensation for all costs involved in disposing of material as specified in this section, including all costs of hauling, shall be considered as included in the price paid for the contract items of work involving such materials and no additional compensation will be allowed therefor.

107.15 Relief from Maintenance and Responsibility. Upon the written request of the Contractor, or upon order of the Engineer, the Contractor may be relieved of the duty of maintaining and protecting certain portions of the work as described below, which have been completed in all respects in accordance with the requirements of the contract and to the satisfaction of the Engineer, and thereafter except with his consent, the Contractor will not be required to do further work thereon. In addition, such action by the Engineer will relieve the Contractor of responsibility for injury or damage to said completed portions of the work resulting from use by public traffic or from the action of the elements or from any other cause, but not from injury or damage resulting from the Contractor's own operations or from his negligence.

Portions of the work for which the Contractor may be relieved of the duty of maintenance and protection as provided in the above paragraph include but are not limited to the following:

(a) The completion of one-fourth (¼) mile of roadway or one-fourth (¼) mile of one roadway of a divided highway or a frontage road including the traveled way, shoulders, drainage control facilities, planned roadway protection work, lighting, and any required traffic control and access facilities.

(b) A bridge or other structure of major importance.

(c) A complete unit of a traffic control signal system or of a highway lighting system.

(d) A complete unit of highway protection work.

(e) Any required traffic control and access facilities if the roadway or structure is to be used by public traffic before completion of the contract.

(f) Non-highway facilities constructed for other agencies.

However, nothing in this subsection providing for relief from maintenance and responsibility will be construed as relieving the Contractor of full responsibility for making good defective work or materials found at any time before the formal written acceptance of the entire contract by the Engineer.

107.16 Contractor's Responsibility for the Work and Materials. Until the acceptance of the contract, the Contractor shall have the charge and care of the work and of the materials to be used therein (including materials for which he has received partial payment as provided in subsection 109.06, "Partial Payments," or materials which have been furnished by the State) and shall bear the risk of injury, loss or damage to any part thereof by the action of the elements or from any other cause, whether arising from the execution or from the non-execution of the work, except as provided in subsection 107.15, "Relief from Maintenance and Responsibility." The Contractor shall rebuild, repair, restore, and make good all injuries, losses, or damages to any portion of the work or the materials occasioned by any cause before its completion and acceptance and shall bear the expense thereof, except as otherwise expressly provided in subsection 203.03.10, "Slides and Slipouts," and subsection 619.05.01, "Culvert Markers and Guide Posts," and except for such injuries, losses, or damages as are directly and approximately caused by acts of the federal government or the public enemy. Where necessary to protect the work or materials from damage, the Contractor shall, at his expense, provide suitable drainage of the roadway and erect such temporary structures as are necessary to protect the work or materials from damage. The suspension of the work from any cause whatever shall not relieve the Contractor of his responsibility for the work and materials as herein specified. If ordered by the Engineer, the Contractor shall, at his expense, properly store materials which have been partially paid for by the State or which have been furnished by the State. Such storage by the Contractor shall be on behalf of the State and

the State shall at all times be entitled to the possession of such materials, and the Contractor shall promptly return the same to the site of the work when requested. The Contractor shall not dispose of any of the materials so stored except on written authorization from the Engineer.

107.17 Contractor's Responsibility for Utility Property and Service. At points where the Contractor's operations are adjacent to properties of railroad, telegraph, telephone, and power companies, or are adjacent to other property, damage to which might result in considerable expense, loss, or inconvenience, work shall not be commenced until all arrangements necessary for the protection thereof have been made.

The Contractor shall not begin any operations which may interfere with or impair the normal service being rendered by public or private utility operators, until such operators have been notified, and shall cooperate with the owners of any underground or overhead utility lines in their removal and rearrangement operations in order that these operations may progress in a reasonable manner, and that duplication of rearrangement work may be reduced to a minimum, and that services rendered by those parties will not be unnecessarily interrupted. The Contractor will be held responsible for the protection of the property of public or private utilities within the limits of the work.

In general, the repair and adjustment of street structures such as pipe lines, services, telephone, telegraph, and electric lines, above or below the ground, will be made by the owners thereof. When included in the proposal, the adjustment of sewer manhole frames and covers, inlets and catch basin frames and covers and the like, will be within the Contractor's responsibility. The Contractor shall see that they are adjusted to conform to the lines, grades, and typical cross sections as shown on the plans, or as prescribed, without respect to whether the repairs and the roughing-in work have been performed by the Contractor or others.

Pipes or other construction shall be maintained in continuous service as far as practicable and shall be properly

protected and supported. In no case shall interruption of the water service be allowed to exist outside of working hours.

Fire hydrants shall be accessible at all times to the fire department. No material or other obstruction shall be placed closer to a fire hydrant than permitted by ordinances, rules, or regulations, or within fifteen (15) feet of the fire hydrant in the absence of such ordinances, rules, or regulations.

The Contractor shall give notice in writing to the proper authorities in charge of streets, gas, water pipes, electric and other conduits, railroads, poles, manholes, catch basins, and all other property that may be affected by the Contractor's operations, at least forty-eight (48) hours before breaking ground.

In the event of interruption to water or utility services as a result of accidental breakage, the Contractor shall promptly notify the proper authority. He shall cooperate with said authority in the restoration of service as promptly as possible.

Attention is directed to subsection 105.06, "Cooperation with Utilities."

107.18 Furnishing Right of Way. The Department will be responsible for the securing of all rights of way shown in the plans. Any exceptions will be indicated in the contract.

107.19 Personal Liability of Public Officials. In carrying out any of the provisions of these specifications or in exercising any power or authority granted to them by or within the scope of the contract, there shall be no liability upon the directors, Engineer, or their authorized representatives, either personally or as officials of the State, it being understood that in all such matters they act solely as agents and representatives of the State.

107.20 No Waiver of Legal Rights. The Department shall not be precluded or estopped by any measurements, estimate, or certificate made either before or after

the completion and acceptance of the work and payment therefor, from showing the true amount and character of the work performed, and materials furnished by the Contractor, nor from showing that any such measurements, estimate, or certificate is untrue or is incorrectly made, nor that the work or materials do not in fact conform to the contract. The Department shall not be precluded or estopped, notwithstanding any such measurement, estimate, or certificate, and payment in accordance therewith, from recovering from the Contractor or his sureties, or both, such damages as it may sustain by reason of his failure to comply with the terms of the contract. Neither the acceptance by the Department, or any representative of the Department, nor any payment for or acceptance of the whole or any part of the work, nor any extension of time, nor any possession taken by the Department, shall operate as a waiver of any portion of the contract or of any power herein reserved, or of any right to damages. A waiver of any breach of the contract shall not be held to be a waiver of any other or subsequent breach.

107.21 Dust Nuisance. Dust nuisance originating from any plant or construction operations either inside or outside the right of way shall be controlled by the Contractor in accordance with local ordinances and regulations at the sole expense of the Contractor in accordance with the provisions of subsection 107.12, "Protection and Restoration of Property and Landscape."

SECTION 108

PROSECUTION AND PROGRESS

108.01 Subletting of Contract. The Contractor shall not sublet, sell, transfer, assign, or otherwise dispose of the contract or contracts or any portion thereof, or of his right, title, or interest therein, without prior written consent of the Engineer and of the surety.

Requests for permission to sublet, assign, or otherwise dispose of any portion of the Contract shall be in writing and accompanied by a letter showing that the organization which will perform the work is particularly experienced for such work.

Consent to sublet, assign, or otherwise dispose of any portion of the contract shall not be construed to relieve the Contractor of his liability under the contract and bonds. The Contractor shall file with the Engineer within seven (7) days after making any subcontract, two (2) certified copies of such subcontract. In preparing such copies, the prices agreed upon for the work may be omitted.

All subcontractors and assignees of the prime or general Contractor shall be required to comply with the provisions of NRS 408.910 in the same manner as the prime or general contractor.

Contract bid prices will prevail for purposes of computing the monetary value of all subcontracts.

The Contractor shall perform with his own organization, work amounting to not less than fifty (50) percent of the combined value of all items of the work covered by the contract except as follows:

(a) Should the Contractor elect to furnish materials for work to be performed by an approved subcontractor, and the materials are not obtained from the same firm that is to perform the work of incorporating said materials into the project, the cost of said materials, when set forth in a written statement accompanying the subcontract agreement or contained therein, will be excluded from amounts applicable to the subcontracted percentage.

When a firm both sells materials to a Contractor and performs the work of incorporating the materials into the project, these two phases of work must necessarily be considered in combination and, as in effect, constituting a single subcontract.

(b) When performed by subcontract, any items that have been selected as "Specialty Items" for the contract will be excluded from amounts applicable to the subcontracted percentage. "Specialty Items" for the contract are listed as such in the special provisions.

Roadside production of materials is construed to be the production of crushed stone, gravel, or other material with portable or semiportable crushing, screening, or washing plants, established or reopened in the vicinity of the work for the purpose of supplying materials to be incorporated into the work on a designated project or projects. Roadside production of materials shall be considered subcontracting if performed by other than the Contractor.

The Department will not recognize any subcontractor on the work as a party to the contract. Nothing contained in any subcontract shall create any contractural relation between the subcontractor and the Department. The Contractor will be held solely responsible for the progress of the work in accordance with progress required.

108.02 Notice to Proceed. An official Notice to Proceed specifying the date by which construction operations shall be started will be issued to the Contractor by the Engineer. Work shall be commenced not later than the date set forth in the Notice to Proceed. The date set forth in the Notice to Proceed shall not be less than twenty (20) days after the Notice to Proceed is issued. Commencement of the work by the Contractor shall be deemed and taken as a waiver of such notice on his part, but in such case he shall notify the Engineer in writing at least forty-eight (48) hours in advance of the date on which he expects to begin work. In no case, however, shall the Contractor begin work prior to the date of approval of the contract. Contract time will begin on the date specified in

the Notice to Proceed, unless operations begin at an earlier date, in which case the date that such operations were begun will apply.

108.03 Prosecution and Progress. When required by the Engineer, the Contractor shall furnish the Engineer with a "Progress Schedule" for his approval. The progress schedule may be used as the bases for establishing major construction operations and as a check on the progress of the work. The Contractor shall provide sufficient materials, equipment, and labor to guarantee the completion of the project in accordance with the plans and specifications within the time set forth in the special provisions. Should the prosecution of the work for any reason be discontinued, the Contractor shall notify the Engineer at least twenty-four (24) hours in advance of resuming operations.

108.04 Limitation of Operations. The Contractor shall conduct the work at all times in such a manner and in such sequence as will assure the least interference with traffic. He shall have due regard to the location of detours and to the provisions for handling traffic. He shall not open up work to the prejudice or detriment of work already started. The Engineer may require the Contractor to finish a section on which the work is in progress before work is started on any additional sections if the opening of such section is essential to public convenience.

No productive work will be required on Saturdays, Sundays, or State recognized holidays. If, however, the Contractor elects to work on such days, those days worked will be charged as working days. The Contractor shall give the Engineer notice of his intention to work on the aforementioned days at least forty-eight (48) hours in advance of such work. State recognized holidays are enumerated in subsection 101.25, "Holidays" of these specifications.

The Engineer is authorized to notify the Contractor in writing and require the Contractor to cease construction operations the day before, during, and the day after said holidays, or at any other time if the Contractor's operations are of such nature, the project is so located, and

traffic is of such volume that it is deemed expedient to do so.

108.05 Character of Workmen; Methods and Equipment. The Contractor shall at all times employ sufficient labor and equipment for prosecuting the several classes of work to full completion in the manner and time required by these specifications.

All workmen shall have sufficient skill and experience to perform properly the work assigned to them. Workmen engaged in special or skilled work shall have sufficient experience in such work and in the operation of the equipment required to perform all work properly and satisfactorily.

Any person employed by the Contractor or by any subcontractor who, in the opinion of the Engineer, does not perform his work in a proper and skillful manner or is intemperate or disorderly, shall, at the written request of the Engineer, be removed forthwith by the Contractor or subcontractor employing such person, and shall not be employed again in any portion of the work without the approval of the Engineer.

Should the Contractor fail to remove such person or persons as required above, or fail to furnish suitable and sufficient personnel for the proper prosecution of the work, the Engineer may suspend the work by written notice until such orders are complied with.

All equipment which is proposed to be used on the work shall be of sufficient size and in such mechanical condition as to meet requirements of the work and to produce a satisfactory quality of work. Equipment used on any portion of the project shall be such that no injury to the roadway, adjacent property, or other highway will result from its use.

When the methods and equipment to be used by the Contractor in accomplishing the construction are not prescribed in the contract, the Contractor is free to use any methods or equipment that he demonstrates to the satisfaction of the Engineer will accomplish the contract work in conformity with the requirements of the contract.

When the contract specifies that the construction be performed by the use of certain methods and equipment, such methods and equipment shall be used unless others are authorized by the Engineer. If the Contractor desires to use methods or types of equipment other than those specified in the contract, he may request authority from the Engineer to do so. The request shall be in writing and shall include a full description of the methods and equipment proposed to be used and an explanation of the reasons for desiring to make the change. If approval is given, it will be on the condition that the Contractor will be fully responsible for producing work in conformity with contract requirements. If, after trial use of the substituted methods or equipment, the Engineer determines that the work produced does not meet contract requirements, the Contractor shall discontinue the use of the substitute method or equipment and shall complete the remaining construction with the specified methods and equipment. The Contractor shall remove the deficient work and replace it with work of specified quality, or take such other corrective action as the Engineer may direct. No change will be made in basis of payment for the construction items involved nor in contract time as a result of authorizing a change in methods or equipment under these provisions.

108.06 Temporary Suspension of Work. The Engineer shall have the authority to suspend the work wholly or in part, for such period as he may deem necessary due to unsuitable weather, or to such other conditions as are considered unfavorable for the suitable prosecution of the work, or for such time as he may deem necessary due to the failure on the part of the Contractor to carry out orders given, or to perform any provision of the contract. The Contractor shall immediately comply with the written order of the Engineer to suspend the work wholly or in part. The suspended work shall be resumed when conditions are favorable and methods are corrected, as ordered or approved in writing by the Engineer.

In the event that a suspension of work is ordered as provided above, and should such suspension be ordered by

reason of the failure of the Contractor to carry out orders or to perform any provision of the contract, or by reason of weather conditions being unsuitable for performing any item or items of work, which work, in the sole opinion of the Engineer, could have been performed prior to the occurrence of such unsuitable weather conditions had the Contractor diligently prosecuted the work when weather conditions were suitable, the Contractor, at his own expense, shall do all the work necessary to provide a safe, smooth and unobstructed passageway through construction for use by public traffic during the period of such suspension as provided in subsection 107.07, "Public Convenience and Safety," and as specified in the special provisions for the work. In the event that the Contractor fails to perform the work above specified, the Department will perform such work and the cost thereof will be deducted from money due or to become due the Contractor.

In the event that a suspension of work is ordered by the Engineer due to unsuitable weather conditions, and in the sole opinion of the Engineer, the Contractor has prosecuted the work with energy and diligence prior to the time that operations were suspended, the cost of providing a smooth and unobstructed passageway through the work will be paid for as extra work as provided in subsection 104.03, "Extra Work," or at the option of the Engineer, such work will be performed by the Department at no cost to the Contractor.

If the Engineer orders a suspension of all of the work or a portion of the work which is the current controlling operation or operations, due to unsuitable weather or to such other conditions as are considered unfavorable to the suitable prosecution of the work, the days on which the suspension is in effect shall not be considered working days as defined in subsection 101.63, "Working Day." If a portion of work at the time of such suspension is not a current controlling operation or operations, but subsequently does become the current controlling operation or operations, the determination of working days will be made on the basis of the then current controlling operation or operations.

If a suspension of work is ordered by the Engineer, due to the failure on the part of the Contractor to carry out orders given or to perform any provision of the contract, the days on which the suspension order is in effect shall be considered working days if such days are working days within the meaning of the definition set forth in subsection 101.63, "Working Day."

In the event of a suspension of work under any of the conditions set forth in this section, such suspension of work shall not relieve the Contractor of his responsibilities as set forth in Section 107, "Legal Relations and Responsibility to the Public."

108.07 Preconstruction Conference. After the contract has been awarded and prior to commencing work, the Engineer may designate a time and place satisfactory to the Contractor for a preconstruction conference. At such time the Engineer will outline detailed requirements to be followed in performance of the contract.

108.08 Determination and Extension of Contract Time. The contract time for completion will be fixed by the Department, and will be stated in the special provisions, either as a calendar date or based on a number of working days. Attention is directed to subsection 101.63, "Working Day."

The Contractor shall perform the work in an acceptable manner within the time stated in the contract except that the contract time for completion may be adjusted as follows:

(a) If satisfactory completion of the contract shall require performance of work in greater quantities than those set forth in the proposal, the time allowed for performance shall be increased in the same ratio as the final estimate bears to the original contract amount, plus such amounts as may be allowed under supplemental agreements and contract change orders. The amount for asphalt cements and liquid asphalts will not be considered in the original or the final estimates for determining time extensions.

(b) In case of suspension of major items of work by order of the Engineer and through no fault of the Contractor, the time for completion shall be extended an amount equal to the elapsed time between effective dates of order to suspend and order to resume.

(c) When delays occur due to unforeseen causes beyond the control and without the fault or negligence of the Contractor, including, but not restricted to acts of God, acts of the public enemy, acts of government agency, fires, floods, epidemics, strikes, and freight embargoes, the time for completion shall be extended an amount determined by the Engineer to be equivalent to the delays; provided, however, written request for such extension of time is made by the Contractor within ten (10) calendar days after the beginning of such delay. No allowance shall be made for delay or suspension of the work due to fault of the Contractor.

The contract time shall begin as set forth in subsection 108.02, "Notice to Proceed." When the final acceptance has been duly made by the Engineer as prescribed in subsection 105.16, "Final Acceptance," the daily time charge shall cease.

108.09 Failure to Complete the Work on Time. Time is an essential element of the contract and it is important that the work be pressed vigorously to completion. The cost to the Department of the administration of the contract, including engineering, inspection, and supervision will be increased as the time occupied in the work is lengthened. The public is subject to detriment and inconvenience when full use cannot be made of an incomplete project.

Should the Contractor fail to complete the work within the time agreed upon in the contract or within such extra time as may have been allowed by increases in the contract or by formally approved extensions granted by the Department, there shall be deducted from any money or amounts due or that may become due the Contractor, the sum set forth in the special provisions for each and every working day that the work shall remain uncompleted. This

sum shall be considered and treated not as a penalty but as liquidated damages due the State from the Contractor by reason of inconveniences to the public, added cost of engineering and supervision and other items which have caused an expenditure of public funds resulting from his failure to complete the work within the time specified in the contract.

Permitting the Contractor to continue and finish the work or any part of it after the time fixed for its completion, or after the date to which the time for completion may have been extended, will in no way operate as a waiver on the part of the Department of any of its rights under the contract.

The Department will waive such portions of the liquidated damages as may accrue after conditions of final acceptance are met, except final clean up.

108.10 Default and Termination of Contract. If the Contractor:

(a) Fails to begin the work under the contract within the time specified in the Notice to Proceed, or

(b) Fails to perform the work with sufficient workmen and equipment or with sufficient materials to assure the prompt completion of said work, or

(c) Performs the work unsuitably or neglects or refuses to remove materials or to perform anew such work as may be rejected as unacceptable and unsuitable, or

(d) Discontinues the prosecution of the work, or

(e) Fails to resume work which has been discontinued within a reasonable time after notice to do so, or

(f) Becomes insolvent or is declared bankrupt or commits any act of bankruptcy or insolvency, or

(g) Allows any final judgment to stand against him unsatisfied for a period of five (5) days, or

(h) Makes an assignment for the benefit of creditors, or

(i) For any other cause whatsoever, fails to carry on the work in an acceptable manner, the Engineer will give notice in writing to the Contractor and his surety of such delay, neglect, or default.

If the Contractor or surety, within a period of ten (10)

days after such notice, shall not proceed in accordance therewith, then the Engineer shall have full power and authority without violating the contract, to take the prosecution of the work out of the hands of the Contractor. The Engineer may, at his option, call upon the surety to complete the work in accordance with the terms of the contract; or he may take over the work, including any or all materials and equipment on the project as may be suitable and acceptable, and may complete the work by force account, or may enter into a new agreement for the completion of said contract according to the terms and provisions thereof, or use such other methods as, in his opinion, will be required for the completion of said contract in an acceptable manner.

All costs and charges incurred by the Department, together with the cost of completing the work under the contract, shall be deducted from any money due or which may become due said Contractor. In case the expense so incurred by the Department shall be less than the sum which would have been payable under the contract if it had been completed by said Contractor, then said Contractor shall be entitled to receive the difference, and in case such expense shall exceed the sum which would have been payable under the contract, then the Contractor and his surety shall be liable and shall pay to the State the amount of said excess.

108.11 Termination of the Contractor's Responsibility. Whenever the improvement contemplated and covered by the contract shall have been completely performed on the part of the Contractor and all parts of the work have been approved and accepted by the Engineer, according to the contract, and the final estimate paid, the Contractor's obligations shall then be considered fulfilled, except as set forth in his contract bond and as provided in subsection 107.11, "Responsibility for Damage Claims."

108.12 Right of Way Delays. If, through the failure of the State to acquire or clear right of way, the Contractor sustains loss which could not have been avoided by the judicious handling of forces, equipment, and plant, there

shall be paid to the Contractor such amount as the Engineer may find to be a fair and reasonable compensation for such part of the Contractor's actual loss, as, in the opinion of the Engineer, was unavoidable, determined as follows:

Compensation for idle time of equipment will be determined in the same manner as determinations are made for equipment used in the performance of extra work paid for on a force account basis, as provided in subsection 109.03, "Extra and Force Account Work," with the following exceptions:

(a) The time for which such compensation will be paid will be the actual normal working time during which such delay condition exists, but in no case will exceed eight (8) hours in any one day.

(b) The days for which compensation will be paid will be the working days charged to the contract except that no compensation will be paid for Saturdays, Sundays, or holidays regardless of working days charged.

Actual loss shall be understood to include no items of expense other than idle time of equipment and necessary payments for idle time of men, cost of extra moving of equipment, and cost of longer hauls. Compensation for idle time of equipment will be determined as provided in this subsection and compensation for idle time of men will be determined as provided in subsection 109.03, "Extra and Force Account Work," and no markup will be added in either case for overhead and profit.

If performance of the Contractor's work is delayed as the result of the failure of the Department to acquire or clear right of way, an extension of time determined pursuant to the provisions in subsection 108.08, "Determination and Extension of Contract Time," will be granted.

SECTION 109

MEASUREMENT AND PAYMENT

109.01 Measurement of Quantities. The measurement and determination of the number of units of each pay item will be made in general as prescribed hereinafter and specifically as set out under Method of Measurement and Basis of Payment in the specification of each pay item.

After the items of work are completed and before final payment is made, the Engineer will determine the quantities of the various items of work performed as the basis for final settlement for all other than lump sum contracts. In the case of unit price items, the Contractor will be paid for the actual amount of work performed and materials used in accordance with these specifications, as shown by the final measurements, unless otherwise specified.

Actual authorized quantities of work satisfactorily completed under the contract, shall be measured by the Engineer in accordance with United States Standard Measures, and well recognized engineer practices. Unauthorized wastings of material will be deducted and only such quantities as are actually incorporated in the completed work will be included in the final estimate.

Unless otherwise specified, longitudinal measurements for area computations will be made horizontally, and no deductions will be made for individual fixtures having an area of nine (9) square feet or less. Unless otherwise specified, transverse measurements for area computation will be the neat dimensions shown on the plans or ordered in writing by the Engineer.

In computing volumes of excavation, embankment, and borrow, the average end area method will be used unless otherwise specified.

All items which are measured by the linear foot such as pipe culverts, underdrains, guardrails, etc., shall be measured parallel to the base or foundation upon which such structures are placed, unless otherwise shown on the plans.

The term "gauge," when used in connection with the measurement of plates, shall mean the U.S. Standard

Gauge. When reference is made, however, to the measurements of galvanized sheets used in the manufacture of corrugated metal pipe, metal plate pipe culverts and arches, and metal cribbing, the term "gauge" shall mean that specified in the respective test designation for that material as described in the "Materials" section of these specifications.

When the term "gauge" refers to the measurement of wire, it shall mean the wire gauge specified in the AASHO Designation: M32 for cold drawn steel wire for concrete reinforcement.

When water meters are required, the accuracy of the meters shall be checked by comparing the actual weight of approximately 1,000 gallons, or 125 cubic feet, as metered with the calculated weight using as a reference density 8.33 pounds per gallon or 62.4 pounds per cubic foot. Unless otherwise specified, water meters shall be accurate to within 2 percent of the indicated amount. The frequency of checking water meters will be determined by the Engineer.

The term ton shall mean the short ton consisting of two thousand (2,000) pounds avoirdupois. All materials which are specified for measurement by ton shall be weighed on accurate, approved scales set at locations designated by the Engineer. All materials shall be weighed on platform scales with the following exception: In lieu of platform scales, the Contractor may provide an automatic printer system which will print the weights of the material delivered, provided the system is used in conjunction with an approved automatic batching control system. Such evidence shall be evidenced by a weigh ticket for each load. The Contractor shall have on hand not less than ten (10) fifty- (50) pound standard weights for testing the scales.

All scales shall be furnished by and at the expense of the Contractor and shall have a certificate of inspection by the Bureau of Weight and Measures. The scales shall be tested and inspected by the Bureau of Weights and Measures and a new inspection certificate required as often as the Engineer may deem necessary, and after each scale move, in order to insure the accuracy of the scales. The

cost of inspecting the scales shall be borne by the Department.

Platform scales shall be of sufficient size and capacity to weight, in one operation, the entire loaded vehicle. Combination vehicles may be weighed as separate units, provided the connecting device between vehicles is so constructed that no weight other than that of the device itself is transmitted to either vehicle. When combination vehicles are used, approaches to and from the scale platform shall be level for sufficient distance to accommodate that portion of the combination vehicle that is off the scale platform. In instances where combination vehicles are weighed, the approaches to and from the scale platform must be level with the scale platform for a minimum distance of fifty (50) feet from each end of the scale platform.

If combination vehicles are utilized, provisions must be made to insure that all braking devices are disengaged during weighing operations as insurance against stresses being transmitted between either vehicle.

The scale pit must be of sufficient width to permit access to all scale components for purposes of inspection, repair, cleaning, and adjusting.

Support members for platform scales shall consist of twelve by twelve inch (12″ x 12″) or six by sixteen inch (6″ x 16″) (minimum) timbers placed on a firm gravel foundation. Scales consisting of more than one section shall be supported with twelve by twelve inch (12″ x 12″) or six by sixteen inch (6″ x 16″) (minimum) timbers at each end of each section to avoid settlement of the scale platform. Concrete support members conforming to the minimum timber size requirements may be utilized in lieu of timber at the Contractor's option.

Platform scales shall be equipped with weatherproof housing so constructed as to protect the recording device and permit the weighmaster convenient access to all beams and dials. The housing shall not be less than six (6) feet wide, eight (8) feet long and seven (7) feet high, and shall have two windows, adjustable for ventilation, one facing the scales, and shall be equipped with an adequate shelf

suitable to the Engineer. The Contractor shall provide heat and electric lights when requested by the Engineer.

Conveyor scales of an approved type may be used. The conveyor scales shall be furnished with one (1) master counter to run continuously and one (1) remote counter which will print the weight in individual loads, then reset to zero automatically. The remote unit shall be placed in a weatherproof house with two (2) windows. One (1) window shall face the point of loading and the conveyor scales. This window shall also be equipped with a shelf two (2) feet wide and six (6) feet long. A controlled method of heating shall be supplied for cold weather operations.

A locked door shall be provided on the access to the conveyor balances (where fine adjustment must be made), the key to be in the hands of the Engineer and to be opened only for maintenance and adjustment of conveyor scales to meet the accuracy of the platform scales. This door shall be locked at all other times during the operation of the conveyor scales.

If conveyor weighing equipment is used, the following procedures shall be followed:

(a) The conveyor scales shall be calibrated against the platform scales, which must have a certificate of inspection.

(b) At the beginning and middle of each shift, or as requested by the Engineer, two consecutive loads of material weighed over the conveyor scales shall be reweighed on the platform scales. The total weight indicated by the conveyor scales on the two loads must check with the platform scale weight within one half of one percent. If the conveyor scales weigh out of this tolerance, all loads shall be weighed on the platform scales until the condition is rectified.

(c) Consecutively numbered, individual weigh tickets must be used with conveyor scale weights stamped by the remote counter.

Unless otherwise specified, materials shipped by rail shall be weighed over the authorized project scales before incorporation into the work.

Cement will be measured by the barrel. The term "barrel" will mean three hundred seventy-six (376) pounds of cement.

Timber will be measured by the thousand feet board measure (Mfbm) actually incorporated in the structure with no allowance for any waste except beveled ends. Measurement will be based on nominal widths and thicknesses, and the extreme length of each piece.

When a complete structure or structural unit (in effect, "lump sum" work) is specified as the unit of measurement, the unit will be construed to include all necessary fittings and accessories.

All materials for which measurements are obtained by the cubic yard "loose measurement" or "measured in the vehicle" shall be hauled in approved vehicles and measured therein at the point of delivery. No allowance will be made for the settlement of material in transit. Vehicles for this purpose may be of any size or type acceptable to the Engineer, provided that the body is of such shape that the actual delivered contents may be readily and accurately determined and will remain constant. Unless all approved vehicles on the work are of uniform capacity, each vehicle must bear a plainly legible identification mark, indicating its specified approved capacity. All vehicles must be loaded to at least their water-level capacity and all loads shall be leveled when the vehicles arrive at the point of delivery. Loads not hauled in approved vehicles or of a quantity less than the specific approved quantity for the hauling vehicle will be subject to rejection and no compensation will be allowed for the hauling of the material.

The unit of measurement for liquid asphalts, asphaltic emulsions, and paving asphalts shall be a ton or gallon.

Quantities of bituminous binders wasted or disposed of in a manner not called for under these specifications, or remaining on hand after completion of the work, will not be paid for.

When permitted by the Engineer, pay quantities of bituminous binder may be determined from volumetric measurements of the bituminous binder, in which case the bituminous binder shall be delivered in calibrated

tanks and each tank shall be accompanied by its proper measuring stick and a calibration card signed by a sealer of weight and measures, and pay quantities shall be determined in accordance with the following procedure.

Volumetric measurements at any temperature shall be reduced to the volume the material would occupy at sixty (60) degrees Fahrenheit, before converting the volumetric measurements to weight.

The following tables shall be used to convert volumes from gallons to weight. All types, SC, MC, and RC of the same grade shall be considered to have equal weights and volume.

Average Weights and Volumes of Liquid Asphalt

Grade of Liquid Asphalt	Gallons Per Ton at 60° F.	Barrels Per Ton at 60° F. (42 U.S. Gals.)	Pounds Per Gal. at 60° F.
70	253	6.03	7.90
250	249	5.93	8.03
800	245	5.83	8.16
3000	241	5.74	8.30

Average Weights and Volumes of Asphalt Cement

Grade	Gallons Per Ton at 60° F.	Barrels Per Ton at 60° F. (42 U.S. Gals.)	Pounds Per Gal. at 60° F.
60– 70	235	5.60	8.51
85–100	235	5.60	8.51
120–150	237	5.64	8.44
200–300	239	5.70	8.36

Average Weights and Volumes of Asphaltic Emulsion

Type of Emulsion	Gallons Per Ton at 60° F.	Barrels Per Ton at 60° F. (42 U.S. Gals.)	Pounds Per Gal. at 60° F.
All grades	240	5.71	8.33

Rental of equipment will be measured by time within one-half (½) hour of actual working time and necessary traveling time of the equipment within the limits of the project. If equipment has been ordered on the job on a standby basis by the Engineer, half-time rates for the equipment will be paid.

When special equipment has been ordered by the engineer in connection with force account work, travel time and transportation to the project will be measured as hereinafter outlined. For the use of special equipment moved

in on the work and used exclusively for extra work paid for on a force account basis, the Contractor will be paid the rental rates listed in the special provisions or determined as provided in subsection 109.03, "Extra and Force Account Work," and for the cost of transporting the equipment to the location of the work and its return to its original location, all in accordance with the following provisions:

(a) The original location of the equipment to be hauled to the location of the work shall be agreed to by the Engineer in advance.

(b) The State will pay the costs of loading and unloading such equipment.

(c) The cost of transporting equipment in low bed trailers shall not exceed the hourly rates charged by established haulers.

(d) The rental period shall begin at the time the equipment is unloaded at the site of the extra work, shall include each day that the equipment is at the site of the extra work, excluding Saturdays, Sundays, and legal holidays unless the extra work is performed on such days, and shall terminate at the end of the day on which the Engineer directs the Contractor to discontinue the use of such equipment. The rental time to be paid per day will be in accordance with the following:

Hours Equipment Is in Operation	Hours To Be Paid
0	4
0.5	4.25
1	4.5
1.5	4.75
2	5
2.5	5.25
3	5.5
3.5	5.75
4	6
4.5	6.25
5	6.5
5.5	6.75
6	7
6.5	7.25
7	7.5
7.5	7.75
8	8
Over 8	Hours in operation

When hourly rates are listed, less than thirty (30) minutes of operation shall be considered to be one-half (½) hour of operation.

When daily rates are listed, payment for one-half (½) day will be made if the equipment is not used. If the equipment is used, payment will be made for one day.

(e) Should the Contractor desire the return of the equipment to a location other than its original location, the State will pay the cost of transportation in accordance with the above provisions, provided such payment shall not exceed the cost of moving the equipment to the work.

(f) Payment for transporting and loading and unloading equipment as above provided will not be made if the equipment is used on the work in any other way than upon extra work paid for on a force account basis.

Material wasted or disposed of in a manner not called for under the contract, material not unloaded from the transporting vehicle, material placed outside of the limits indicated or given on the plans, or material remaining on hand after completion of the work will not be paid for except as otherwise provided.

109.02 Scope of Payment. Unless otherwise provided under "Basis of Payment," payments to the Contractor will be made for the actual quantities of contract items performed in accordance with the plans and specifications, and if, upon completion of the construction, these actual quantities show either an increase or decrease from the quantities given in the bid schedule, the contract unit prices will still prevail, except as provided in subsection 109.04, "Eliminated Items," and 104.02, "Increased or Decreased Quantities and Change in Character of Work."

Except as provided in 107.16, "Contractor's Responsibility for the Work and Materials," the Contractor shall accept the compensation, as herein provided, in full payment for the following:

(a) The work complete, including all supervision, labor, material, tools, equipment, and incidentals necessary for all work contemplated and embraced under the contract;

(b) Any loss or damage due to the nature of the work, the action of the elements, strikes or lockouts;

(c) Accidents to employees or the public, or both;

(d) Unforeseen difficulties or obstructions which may arise or be encountered during the prosecution of the work;

(e) All risks whatsoever connected with the work under contract until it is accepted by the Engineer;

(f) All expenses incurred by or in consequence of, the suspension or discontinuance of the prosecution of the work as herein specified, and in completing the work and the whole thereof, including the carrying out of all the requirements of these "general requirements and covenants" in an acceptable manner according to the plans and specifications.

If the "Basis of Payment" clause in the specifications relating to any unit price in the bid schedule requires that the said unit price cover and be considered compensation for certain work or material essential to the item, this same work or material will not also be measured or paid for under any other pay item except as provided for in subsection 104.05, "Rights in and Use of Materials Found in the Work."

The payment of any partial estimate or of any retained percentage, except by and under the approved final estimate and voucher, in no way shall affect the obligation of the Contractor to repair or renew any defective parts of the construction or to be responsible for all damages due to such defects.

Those subsections containing pay items of bituminous materials are subject to the following requirements:

It is agreed by the parties to the contract that (a) in case the bituminous material does not conform to the requirements set forth in Section 703, "Bituminous Materials," damage will be sustained by the Department, and that (b) it is extremely difficult to ascertain the actual damage which the Department will sustain; therefore, it is agreed the Contractor will pay to the Department as liquidated damages or the Department, at its option, may deduct

from any money due or to become due the Contractor from the Department an amount set forth in the following schedule.

Number of Demerits (From Section 703, "Bituminous Materials")	Liquidated Damage (per bid unit)
1–2	$1.00
3–5	2.00
6–9	4.00
10–14	8.00
15–20*	16.00

*Material shown by test to have 21 or more demerits shall be removed and replaced, or at the option of the Engineer, may be left in place without payment.

109.03 Extra and Force Account Work. Extra work shall be paid for in accordance with the accepted contract change order. Work specified in the order to be performed at agreed unit prices shall be paid for in the same manner as proposal items.

When extra work paid for on a force account basis is performed by forces other than the Contractor's organization, the Contractor shall reach agreement with such other forces as to the distribution of the payment made by the Department for such work. No additional payment therefor will be made by the Department by reason of the performance of the work by a subcontractor or other forces.

Work specified and performed on a force account basis shall be paid for as follows:

(a) Labor. The Contractor will be paid the cost of labor for the workmen (including foremen when authorized by the Engineer), used in the actual and direct performance of the work. The cost of labor, whether the employer is the Contractor, subcontractor, or other forces, will be the sum of the following:

1. Actual Wages Plus Vacation Pay. The actual wages paid, plus vacation pay, which shall not include any employer payments to, or on behalf of, workmen for health and welfare, pension, and similar purposes.

2. Labor Surcharge. To the actual wages, plus vacation pay, as defined above, will be added a labor surcharge set forth in the special provisions, which labor surcharge shall constitute full compensation for all payments imposed by state and federal laws and for all other

payments made to, or on behalf of, the workmen, other than actual wages as defined in (1) above, and subsistence and travel allowance as specified in (3) below.

3. Subsistence and Travel Allowance. Subsistence and travel allowance paid to such workmen as required by collective bargaining agreements.

To the total of the direct costs computed above, there will be added a markup of twenty (20) percent.

(b) Materials. For materials accepted by the Engineer and used in the work the Contractor shall receive the actual cost of such materials, to which cost shall be added an amount equal to fifteen (15) percent of the sum thereof.

(c) Equipment. For any machinery or special equipment (other than small tools) including fuel and lubricants, the use of which has been authorized by the Engineer, the Contractor shall receive the rental rates which shall be the contract rate.

The Contractor will be paid for the use of equipment at the rental rates applicable to and listed for such equipment in the special provisions, regardless of ownership and any rental or other agreement, if such may exist, for the use of such equipment entered into by the Contractor. If it is deemed necessary by the Engineer to use equipment not listed in the special provisions, a suitable rental rate for such equipment will be established by the Engineer. The Contractor may furnish any cost data which might assist the Engineer in the establishment of such rental rate. Except as provided in subsection 109.01, "Measurement of Quantities," payment will be made for actual time that such equipment is in operation on the work, or for standby time, to which rental sum five (5) percent shall be added.

(d) Supervision and Tools. No additional allowance shall be made for general superintendents, the use of small tools or other costs for which no specified allowance is herein provided.

(e) Records. At the end of each day the Contractor's representative and the Engineer shall compare records of the cost of the work to be done as ordered on a force account basis.

(f) Documentation.

1. Labor. No payment will be made for labor performed on force account work until the Contractor shall furnish to the Engineer, certified copies of payrolls covering that period when the force account work was performed. The payrolls shall indicate name, classification, dates, daily hours, and hourly rate for each workman.

2. Materials. Original receipted invoices, including transportation charges, shall be furnished the Engineer. However, if materials used on the force account work are not specifically purchased for such work, but are taken from the Contractor's stock, then in lieu of the invoices, the Contractor shall furnish an affidavit certifying that such materials were taken from his stock, that the quantity claimed was actually used, and that the price and transportation claimed represent the actual cost to the Contractor.

109.04 Eliminated Items. Should any items contained in the proposal be found unnecessary for the proper completion of the work, the Engineer may, upon written order to the Contractor, eliminate such items from the contract, and such action shall in no way invalidate the contract. When a Contractor is notified of the elimination of items, he will be reimbursed for actual work done and all costs incurred, including mobilization of materials prior to said notification.

109.05 Common Carrier Rate Adjustments. It is understood and agreed that the accepted proposal for the work is based on common carrier rates on file with the Interstate Commerce Commission, or with a corresponding intrastate commission or body and in effect on the date of opening of bids. Payments to the Contractor will be adjusted to compensate for increases and decreases in cost due to changes in common carrier rates becoming effective after the date of opening of proposals, and before the date stipulated for the completion of the work, including authorized extensions of time. Adjustments shall be limited to materials entering into and forming a part of the project and to an amount determined as follows: Adjustments shall be the product of the increase or decrease of said

common carrier rates multiplied by the net quantity of material shipped at the new rates to the work, all as shown by the receipted common carrier bill.

109.06 Partial Payment. Partial payments will be made once each month as the work satisfactorily progresses. The progress estimates shall be based upon materials in place, or on the job site and invoiced, and labor expended thereon. From the total of the amount ascertained will be deducted an amount equivalent to ten (10) percent of the whole, which ten (10) percent will be retained by the Department until after completion of the entire contract in an acceptable manner; and the balance or an amount equivalent to ninety (90) percent of the whole, plus all previous payments shall be certified for payment, provided that any time after fifty (50) percent of the work has been completed, the Engineer may, if he finds that satisfactory progress is being made, make any of the remaining partial payments in full.

No such estimate or payments shall be required to be made, when, in the judgment of the Engineer, the work is not proceeding in accordance with the provisions of the contract, or when in his judgment the total value of the work done since last estimate amounts to less than five hundred ($500) dollars.

Partial payments may be made on "Local Materials" meeting the requirements hereinafter outlined:

(a) Materials shall be stockpiled on or in the vicinity of the project (generally on land adjacent to the project).

(b) All materials shall be stored in an approved manner in areas where damage from flood waters is not likely to occur. If at any time stored materials are lost or become damaged by floods or in any other manner, the Contractor will be responsible for the repair and replacement of such damaged materials. If payment has been made prior to such damage, the amount so allowed, or a proportionate part thereof, shall be deducted from the next partial payment and withheld until satisfactory repairs or replacements have been made.

(c) Partial payments will be made only on materials

that conform to plans and specifications (not to be construed as final acceptance). The quantities will be determined by volume measurement and converted to tons if the contract unit price of the item is in tons. In the case of "Portland Cement Concrete Pavement," the unit price will be converted to square yards per ton. However, partial payments shall not exceed the actual cost to the Contractor to produce the material.

(d) No payment shall be made on any commercial stockpile or on any stockpile from which materials are being used for any purpose whatsoever other than incorporation into the project.

(e) Partial payment shall be made at the contract unit price for the percentage of material allowed. The quantity in stockpile, or windrow, to be considered shall not exceed that required for the project.

(f) Schedule of Payments.

1. Not more than forty (40) percent of the quantity of Class A and Class B Aggregate Base Courses in the stockpile may be allowed. Not more than eighty-five (85) percent of the quantity of Class B Aggregate Base Courses in the processed windrow on the roadway may be allowed.

2. Not more than thirty (30) percent of the quantity of Cement Treated Base Aggregate (Roadmix or Plantmix) in the stockpile may be allowed. Not more than eighty-five (85) percent of the quantity of Cement Treated Base Roadmix in the processed windrow on the roadway (prior to adding cement) may be allowed.

3. Not more than twenty (20) percent of the quantity of Plantmix Base, Surface, or Open-Graded Surface Aggregate in the stockpile may be allowed.

4. Not more than eighty-five (85) percent of the quantity of Roadmix Bituminous Surface Aggregate in the processed windrow on the roadway (prior to adding bituminous material) may be allowed.

5. Not more than forty (40) percent of the quantity of screenings in the stockpile may be allowed.

If materials are not specifically purchased for the work,

but are taken from the Contractor's stock, then in lieu of invoices, there shall be submitted to the Engineer, statements accompanied by an affidavit of the Contractor, certifying such materials were taken from his stock and the price and transportation claimed represent the actual cost to the Contractor.

No partial payment will be made on living or perishable plant materials until planted.

Unless otherwise specified, all material and work covered by partial payments shall thereupon become the property of the State, but this provision shall not be construed as relieving the Contractor from the sole responsibility for all materials and work upon which payments have been made or the restoration of any damaged work, or as a waiver of the right of the Department to require the fulfillment of all terms of the contract.

Partial payments will be made on the items of "Watering," "Construction Signs," and "Barricades" as hereinafter outlined:

(a) Watering. The first monthly estimate after an adequate water supply is developed, will show this item as forty (40) percent complete. Additional payment will be made on the first monthly estimate if job progress so warrants. The remaining percent will be prorated in accordance wth job progress. However, if the water supply becomes inadequate for job requirements, an adjustment downward shall be made on the first monthly estimate following a failure of the water supply. When adequacy is restored, the estimate shall again be adjusted. This item is to be shown as one hundred (100) percent complete on the first monthly estimate after all items requiring water have been completed in accordance with the plans and specifications.

(b) Construction Signs. When construction signs are placed on the project, in accordance with the plans and specifications, fifty (50) percent of the contract price per square foot of acceptable signs in place will be paid for on the next monthly estimate after placing. The remaining percent will be prorated in accordance with job progress.

However, if signing becomes inadequate for job requirements, in the opinion of the Engineer, an adjustment downward shall be made on the first monthly estimate following such inadequacy.

(c) Barricades. When barricades are placed on the project, in accordance with the plans and specifications, fifty (50) percent of the contract price per each of the barricades thus in use will be paid for on the next monthly estimate after placing. The remaining percent will be prorated in accordance with job progress. However, if barricades become inadequate for job requirements, in the opinion of the Engineer, an adjustment downward shall be made on the first monthly estimate following such inadequacy.

Partial payments will be made on the items of fence, guardrail and bridge rail as hereinafter outlined:

(a) Fence. When fencing material is stored on the project, invoice prices may be paid as outlined herein. When the fence posts have been placed, sixty (60) percent of the partially completed fence will be eligible for payment at the contract unit bid price. The remaining forty (40) percent will be eligible for payment when the item is complete.

(b) Guardrail and Bridge Rail. When guardrail and bridge rail materials are stored on the project, invoice prices may be paid as outlined herein. When guardrail and bridge rail are in place, but not painted, ninety (90) percent of the guardrail or bridge rail will be eligible for payment at the contract unit bid price. The remaining ten (10) percent will be eligible for payment when the item is complete.

109.07 Acceptance and Final Payment. When the final inspection and final acceptance have been duly made by the Engineer, as provided in subsection 105.16, "Final Acceptance," and subject to the terms of subsection 108.09, "Failure to Complete the Work on Time," the Engineer shall prepare the final estimate of the quantities of the various classes of work performed under the contract. The Contractor shall examine such estimate and

notify the Engineer in writing of his agreement or file a specific claim covering disputed quantities. Failure on the part of the Contractor to so notify the Engineer or file a claim within a period of thirty (30) days after receipt of the estimate shall be construed to signify the Contractor's agreement to the quantities as set forth, and he shall have no further claim against the Department, except as indicated in the final estimate of quantities. Final payment shall be due and payable at the expiration of not less than thirty (30) calendar days nor more than sixty (60) calendar days from the date of final acceptance.

Final acceptance of the work by the Engineer shall be withheld until the Contractor furnishes all certificates, guaranties, releases, affidavits, etc., required by these specifications or the special provisions.

SECTION 110

WAGES AND CONDITIONS OF EMPLOYMENT

110.01 Description. The provisions pertaining to wages and conditions of employment shall apply to all work performed (on the contract) by the Contractor with his own organization and with the assistance of workmen under his immediate superintendence, and to all work performed on the contract by subcontractors.

110.02 Laws Cited. The Contractor's attention is directed particularly to the provisions and requirements of the following:

(a) Wages, Hours, and Employment on Public Works—Nevada Revised Statutes, Chapter 338.

(b) Nevada Industrial Insurance Act—Nevada Revised Statutes, Chapter 616. (The Contractor will be required to furnish a certificate from the Nevada Industrial Commission as evidence that he has paid all the premiums and percentages as required by the act, and said certificate shall be furnished the Engineer before any work is commenced.)

(c) Unemployment Compensation Law—Nevada Revised Statutes, Chapter 612.

(d) Highway Camp Sanitation—Nevada Revised Statutes, Secs. 444.130, 444.200 and 444.210.

(e) Highways and Roads Law—Nevada Revised Statutes, Chapter 408.

(f) Fair Labor Standards Act of 1938 (52 Stat. 1060).

(g) Work Hours Act of 1962.

(h) Any and all legislation, rules, or regulations promulgated by the State of Nevada, or its agencies, covering any work performed by the Contractor.

DIVISION II

CONSTRUCTION DETAILS

SECTION 201

CLEARING AND GRUBBING

DESCRIPTION

201.01.01 General. This work shall consist of clearing, grubbing, removing, and disposing of all vegetation and debris within the limits of construction, except such objects as are designated to remain or be removed in accordance with other sections of these specifications. This work shall also include the preservation from injury or defacement of all vegetation and objects designated to remain.

CONSTRUCTION

201.03.01 General. The Engineer will establish clearing limits and designate all trees, shrubs, plants, and other things to remain. Areas to be cleared will be as set forth in subsection 201.03.02, "Areas to be Cleared." The Contractor shall preserve all things designated to remain. Paint required for cut or scarred surfaces of trees or shrubs selected for retention shall be an approved asphaltum base paint prepared especially for tree surgery.

201.03.02 Areas to be Cleared. Areas to be cleared shall be one or more of the following:

(a) The entire area upon which highway construction is to be performed to the width of the excavation and embankment slope lines, except where slopes are to be rounded, in which case the area shall extend to the outside limits of slope rounding, as detailed on standard drawing "Standard Slope Rounding and Warping."

(b) Flat Bottom ditch and dike areas to the width of the slope lines.

(c) Areas on which service highway or ramps, streets,

approaches, and all other accessory roads and connections are to be constructed, such areas to extend to the width of the excavation and embankment slope lines.

(d) Material sites and designated borrow pits.

(e) Areas designated in the plans or special provisions.

201.03.03 Clearing and Grubbing. All surface objects and all trees, stumps, roots, and other protruding obstructions, designated for removal, shall be cleared or grubbed or both. Unless otherwise specified, the Contractor may leave stumps and nonperishable solid objects provided they do not extend more than six (6) inches above the ground line or low water level, and are a minimum of three (3) feet below subgrade or embankment slope.

The Engineer may permit sound stumps to be cut off not more than six (6) inches above the ground and to be left outside of the construction limits of cut and embankment areas, except in the area to be rounded at the top of backslopes where stumps are to be cut off flush with or below the surface of the final slope line.

Where feasible, trees shall be felled toward the center of the area to be cleared. Where trees cannot be felled without danger to traffic or injury to other trees, structures, or property, they shall be cut in sections from the top down.

If perishable material is burned, it shall be burned under the constant care of competent watchmen at such times and in such a manner that anything designated to remain on the right of way, the surrounding forest cover, or other adjacent property will not be jeopardized. Burning shall be done in accordance with applicable laws and ordinances. Attention is directed to subsection 107.13, "Forest Protection."

When permitted by the Engineer, materials and debris which is not burned and perishable materials may be removed from the right of way and disposed of at locations off the project outside the limits of view from the project with the written permission of the property owner on whose property the materials and debris are placed. The Contractor shall make all necessary arrangements with property owners for obtaining suitable disposal locations and the cost involved shall be included in the unit price

bid. Attention is directed to subsection 107.14, "Disposal of Material Outside Highway Right of Way."

Except in areas to be excavated, stump holes and other holes from which obstructions are removed shall be backfilled with suitable material and compacted in accordance with subsection 203.03.17, "Compaction, Dirt Embankment" or 203.03.18, "Compaction, Rock Embankment" if within the roadway prism. Payment for backfilling and compacting will be considered subsidiary to other items of the work and no further compensation will be made therefor.

All merchantable timber in the clearing area shall become the property of the Contractor unless otherwise provided. Timber and debris may be stored or decked within the right of way only in areas approved by the Engineer and must be removed or burned prior to final acceptance of the project.

Low hanging branches and unsound or unsightly branches on trees or shrubs designated to remain shall be removed as directed. Branches of trees extending over the roadbed shall be trimmed to give a clear height of twenty (20) feet above the roadbed surface. All trimming shall be done by skilled workmen and in accordance with good tree surgery practices.

Scalping shall include the removal of material such as brush, roots, sod, grass, residue of agricultural crops, sawdust, and decayed vegetable matter from the surface of the ground.

Unless otherwise permitted by the Engineer, the Contractor shall scalp areas where excavation or embankment is to be made, except that mowed sod need not be removed where the embankment to be constructed is four (4) feet or more in height to subgrade elevation.

METHOD OF MEASUREMENT

201.04.01 Measurement. Measurement will be by one or more of the following alternate methods:

(a) Area Basis. The work to be paid for will be the number of acres and fractions thereof acceptably cleared or grubbed or both within the limits staked for clearing and

grubbing by the Engineer. Unless otherwise specified, material sites, borrow pits, and areas not shown on the plans or not staked for clearing and grubbing will not be measured for payment.

(b) Lump Sum Basis. When the bid schedule contains a clearing and grubbing lump sum item, no measurement of area will be made.

(c) Linear Basis. When a linear unit quantity is shown on the bid schedule, the length will be measured along the construction centerline in stations or miles.

(d) Individual Unit Basis.

1. The diameter of trees will be measured at a height of twenty-four (24) inches above the ground. Trees less than six (6) inches in diameter will be classed as brush.
2. Stumps will be measured by individual count.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

201.05.01 Payment. The accepted quantities of clearing and grubbing measured as provided in subsection 201.04.01, "Measurement," will be paid for at the contract prices as follows:

(a) Area Basis. The quantities determined will be paid for at the contract unit price bid per acre respectively for each of the particular pay items listed that appear in the bid schedule.

(b) Lump Sum Basis. When the bid schedule contains a lump sum item the contract lump sum price bid will be paid and shall be full compensation for the work.

(c) Linear Basis. When linear quantities are shown in the bid schedule, the quantities will be paid at the contract unit price bid for this item.

(d) Individual Unit Basis. When individual unit quantities are shown on the bid schedule, the accepted quantities will be paid for at the contract unit price bid for the respective items.

Where trees are designated for removal on a unit "each" basis, payment therefor will be for their complete removal

unless stumps are permitted to remain as set forth in subsection 201.03.03, "Clearing and Grubbing."

(e) Exclusion. When the bid schedule does not contain an estimated quantity or a lump sum item for clearing and grubbing, the work will not be paid for directly, but will be considered as a subsidiary obligation of the Contractor under other contract items.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Clearing and Grubbing	Acre, Stations, Miles, Lump Sum
Remove Trees	Each
Remove Stumps	Each

SECTION 202

REMOVAL OF STRUCTURES AND OBSTRUCTIONS

DESCRIPTION

202.01.01 General. This work shall consist of the removal, wholly or in part, and satisfactory disposal of all buildings, fences, guardrail, structures, old pavement, abandoned pipe lines, and any other obstructions which are not designated or permitted to remain, except for the obstructions to be removed and disposed of under other items in the contract. It shall also include the salvaging of designated materials and backfilling the resulting trenches, holes, and pits.

CONSTRUCTION

202.03.01 General. The Contractor shall raze, remove and dispose of all buildings and foundations, structures, guardrail, culvert markers and guide posts, fences, and other obstructions, any portions of which are on the right of way, except utilities and those for which other provisions have been made for removal. All designated salvable material shall be removed, without unnecessary damage, in sections or pieces which may be readily transported, and shall be stored by the Contractor at specified places within the project limits. Unusable perishable material shall be destroyed. Nonperishable material may be disposed of in accordance with subsection 107.14, "Disposal of Material Outside Highway Right of Way." Basements or cavities left by structure removal shall be filled to the level of the surrounding ground and, if within the prism of construction, shall be compacted in accordance with subsections 203.03.17, "Compaction, Dirt Embankment" or 203.03.18, "Compaction, Rock Embankment."

202.03.02 Removal. Bridges, culverts, and other drainage structures in use by traffic shall not be removed until satisfactory arrangements have been made to accommodate traffic.

All operations necessary for the removal of any existing structure which might endanger the new construction shall be completed prior to the construction of the new work. No equipment or devices shall be used which might damage structures, facilities, or properties which are to be preserved and retained.

Unless otherwise directed, the substructures of existing structures shall be removed down to the natural stream bottom and those parts outside of the stream shall be removed down one foot below natural ground surface. Where such portions of existing structures lie wholly or in part within the limits for a new structure, they shall be removed as necessary to accommodate the construction of the proposed structure.

Blasting or other operations necessary for the removal of an existing structure or obstruction, which may damage new construction, shall be completed prior to placing the new work.

In removing concrete or bituminous pavement, curb, curb and gutter, sidewalk, and similar structures, where portions of the existing structures are to be left in the surface of the finished work, the structure shall be removed to an existing joint, or cut and chipped to a true line with a face perpendicular to the surface of the existing structure. Sufficient removal shall be made to provide for proper grades and connections in the new work.

In removing manholes, catch basins, and inlets, any live sewers connected to them shall be rebuilt and properly reconnected and a satisfactory by-pass service shall be maintained during such construction operations. When abandoning manholes, catch basins, and inlets, they shall be thoroughly cleaned and existing pipe connections shall be plugged with concrete of the class and grade specified for structures. The portions of the structures shall then be removed to the required elevations.

202.03.03 Extensions. Where existing culverts and bridges are to be extended or otherwise incorporated in the new work, only such part or parts of the existing structure shall be removed as is necessary to provide a proper connection to the new work. The connecting edges shall be

cut, shaped, and trimmed to the required lines and grades without weakening or damaging the part of the structure to be retained. Reinforcing bars which are to be left in place so as to project into the new work as dowels or ties, shall not be injured during removal of concrete.

202.03.04 Closing Culverts. Existing culverts within construction limits, the top of which are five (5) feet or more below finished roadway grade, shall be abandoned and closed unless otherwise noted on the plans. The headwalls of such culverts, or any part of the structure that is within three (3) feet of the finished grade line shall be removed. The ends of the culvert shall be completely filled with satisfactory soil for a distance of at least two (2) feet, plus the height of the opening of the structure.

202.03.05 Salvage. When specified, gravel, roadmix, or plantmix surface suitable for reuse shall be removed to the depth required and surfacing so removed shall be carefully salvaged and placed in compact stockpiles at locations approved by the Engineer. Care shall be exercised to prevent contamination of stockpiled material. Any remaining unsuitable material shall be scarified and incorporated in embankment as set forth in Section 203, "Excavation and Embankment."

Fences and gates designated for reuse shall be removed in such a manner that so far as practicable all material can be salvaged. Wire shall be carefully removed from the posts and rolled in rolls of such size that can be conveniently handled. Posts shall be removed by methods that will keep breakage to a minimum.

Guardrail, culvert markers, and guide posts designated for reuse shall be removed in such a manner that so far as practicable all material can be salvaged. Bolts, supports, and other hardware shall be removed from all rails, plates, and posts and all parts shall be sorted and stored at the locations specified. Rail, plates, and posts shall be properly stacked and miscellaneous hardware shall be sacked or boxed and reasonable care exercised in the handling, storage, and preservation of materials as will insure the maximum salvage value for the entire operation. Attention is

directed to Sections 618, "Guardrail" and 619, "Culvert Markers and Guide Posts."

When specified for salvage, structural steel removed from old structures shall be stored in a neat and presentable manner on blocking and at locations suitable for loading. Structures or portions thereof which are specified for re-erection shall be stored in separate piles.

When relay culvert pipe is required, the Contractor shall remove the pipe in such a manner as not to damage the material in any way. If no particular pipe is noted for relay, the Contractor shall salvage and clean sufficient amount of the better grade of pipe to satisfy the relay pipe item. Attention is directed to subsection 604.03.04, "Relay Culvert Pipe."

Timber or piling from all structures designated to be salvaged shall have all nails and bolts removed therefrom and shall be stored in neat piles at locations suitable for loading.

202.03.06 Disposing of Materials. Unless otherwise provided, excavated material shall be used in backfilling excavations made in removing the structure, in constructing embankment, or otherwise disposed of in a manner satisfactory to the Engineer.

When the construction of riprap and similar structures is included in the proposal, suitable broken concrete or masonry removed from old structures may be used in such construction. Any concrete or masonry which cannot be placed in backfills or embankments or used as riprap, shall be disposed of in such a manner as to prevent damage to property or the creation of unsightly conditions. The material shall not be placed where it will obstruct any drainage course.

When concrete or masonry is placed in embankments, it shall be placed in accordance with subsection 203.03.15, "Embankment Material."

Any material removed and not designated for salvage shall become the property of the Contractor and shall be removed from the project prior to completion thereof.

Attention is directed to subsection 107.14, "Disposal of Material Outside Highway Right of Way."

METHOD OF MEASUREMENT

202.04.01 Measurement. When the contract stipulates that payment will be made for removal of structures and obstructions on a lump sum basis, the pay item will include removal of all structures and obstructions encountered within the right of way in accordance with the provisions of this section. Where the proposal stipulates that payment will be made for the removal of specific items on a unit basis, measurement will be made by the unit stipulated in the contract.

The length of pipe removed will be measured in linear feet, by measuring in place prior to removal.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

202.05.01 Payment. The accepted quantities of removal of structures and obstructions will be paid for at the contract lump sum price bid, which price shall be full compensation for removing and disposing of the obstructions in accordance with the contract, including excavation and subsequent backfill.

Specific obstruction items, including pipe removal, stipulated for removal and disposal under unit price pay items will be paid for at the contract unit price bid per unit specified in the proposal—which price shall be full compensation for removal and disposal of such items, excavation and subsequent backfill incidental to their removal. The price shall also include salvage of materials removed, their custody, preservation, storage on the right of way, and disposal as provided herein.

When the proposal does not include any pay item or an appropriate pay item for removal of any structure or obstruction as set forth in this section, such work shall be performed and payment therefor will be considered as subsidiary to other items of work. No additional compensation will be allowed.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Removal of Structures and Obstructions	Lump Sum
Removal of	Each, Linear Feet, Stations, Miles, Square Yards

SECTION 203

EXCAVATION AND EMBANKMENT

DESCRIPTION

203.01.01 General. This work shall consist of grading and excavating the roadway, excavating borrow pits, removing slide material, and excavating ditches and stream channels and satisfactorily disposing of all excavated material and all work necessary for the construction and completion of cuts, embankments, slopes, ditches, dikes, stream channels, approaches, parking areas, intersecting driveways and highways, and subsidiary work. Exceptions are overhaul, slope rounding, or other separately designated pay items of work which are made a part of the contract. All work shall be in reasonably close conformity with the alignment, grades, and cross sections shown on the plans or established by the Engineer.

MATERIALS

203.02.01 Roadway Excavation. Roadway excavation shall consist of all excavation involved in grading and constructing the roadway and appurtenances, irrespective of the nature or type of material encountered; except excavation designated as structure excavation, drainage excavation, channel, and borrow excavation when these items are provided as items of work under the contract. Dividing the project into construction stages shall not be construed as separate material classification.

203.02.02 Drainage Excavation. Drainage excavation shall include all excavation in the construction of open ditches less than twelve (12) feet in bottom width, excepting ditches that are part of the roadway prism as shown in the plans. The nature or type of material encountered shall have no bearing on the classification of material.

203.02.03 Channel Excavation. Channel excavation shall include all excavation in the construction of open

ditches or stream changes with a bottom width of twelve (12) feet or more with the exception of ditches that are part of the roadway prism as shown in the plans. The nature or type of material encountered shall have no bearing on the classification of material.

203.02.04 Borrow. Borrow shall consist of approved material required for the construction of embankments or for other portions of the work, and shall be obtained from approved sources. The widening of roadway cuts shall be considered as roadway excavation and not as borrow, unless otherwise specified. Borrow excavation will not be classified according to type or character of material encountered in the borrow area unless otherwise required in the special provisions.

CONSTRUCTION

203.03.01 Roadway. All excavation shall be made true to lines and grades staked by the Engineer and shall be so conducted as to avoid removing or loosening any material outside the required slopes. If any material is so disturbed it shall be replaced and thoroughly compacted to the required cross section, unless such replacement is impractical as determined by the Engineer.

The work done under this section shall begin at some definite point or points on the project, and be carried forward in an approximately completed manner. The roadway shall be graded to full cross section width before placing base or surfacing of any type, unless otherwise specified.

Intersecting roads, service highways, ramps, approaches, and driveways shall be graded as shown on the plans or established by the Engineer.

All suitable material removed from the excavation shall be used as far as practicable in the formation of embankments, subgrade, shoulders, slopes, dikes, and backfill for structures, unless otherwise indicated on the plans or disposed of in a manner satisfactory to the Engineer. Excavated material shall not be wasted without permission.

203.03.02 Unsuitable Material. Unsuitable material shall be defined as saturated or unsaturated mixtures of

soils or organic matter not suitable for foundation material regardless of moisture content. Material that is unsuitable for planned use, including material below the natural ground surface in embankment areas, shall be excavated and disposed of in a manner approved by the Engineer or as specified in the contract documents.

When unsuitable material is removed and disposed of, the resulting space shall be filled with material suitable for the planned use. Such suitable material shall be placed and compacted in layers as hereinafter specified under embankment.

Disposal of material outside the right of way shall be in accordance with subsection 107.14, "Disposal of Material Outside Highway Right of Way."

203.03.03 Blasting. Any material outside the authorized cross section on the backslopes which may be shattered or loosened because of blasting shall be removed by the Contractor at his expense. Shattered or loosened material below the bottom limits of required excavation shall be uniformly distributed and compacted or otherwise disposed of in a manner satisfactory to the Engineer. The Contractor shall discontinue any method of blasting which leads to overshooting or is dangerous to the public or destructive to property or to natural features.

The use of coyote holes in blasting is prohibited.

Attention is directed to subsection 107.10, "Explosives."

203.03.04 Rock Cuts. In excavating side hill rock cuts and rock cliffs, the Contractor shall exercise care and use precautionary methods so as not to break down, loosen, or otherwise damage supporting rock below the bottom limits of required excavation. In general, such cuts shall be worked from the top of lifts of such height that will not damage the bench of rock below the bottom limits of required excavation. The Contractor shall be responsible for the methods used, and for any damages to the roadbed resulting from his operations.

The slope of all rock cuts shall be scaled and dressed to a safe, stable condition by removing all loose spalls and

rock not firmly keyed to the rock slope. Overhanging rock shall be removed when, in the opinion of the Engineer, it may be a hazard to public use of the roadway.

In solid rock excavation, slopes shall be constructed to the approximate neat lines staked by the Engineer. No rock shall project or overhang more than twelve (12) inches from the true slope.

203.03.05 Overbreak. Overbreak is that portion of material excavated, displaced or loosened outside and beyond the slopes or grade as staked or reestablished, regardless of whether any such overbreak is due to blasting, the inherent character of any formation encountered, or to any other cause. Slides and slipouts as defined in subsection 203.03.10, "Slides and Slipouts," and that portion of rock subgrade as hereinafter set forth, shall not be considered overbreak. All side slope overbreak as so defined shall be removed by the Contractor and shall be disposed of by the Contractor in the same manner as provided for the surplus under the heading of "Surplus Material," but at his own expense and without any allowance for overhaul.

Rock removed to a maximum depth of six (6) inches below subgrade will be measured for payment as described in subsection 203.04.01(b), "Overbreak."

203.03.06 Slopes. All excavation and embankment slopes, except in solid rock, shall be trimmed to the lines staked by the Engineer. The degree of smoothness shall be that normally obtained by hand shovel operations.

203.03.07 Widening Cuts. If the Engineer directs the Contractor to excavate beyond the limits of the typical cross section originally proposed and within the limits of the right of way, the Contractor shall do so and compensation therefor will be as set forth in subsection 203.04.01(c), "Widening Cuts."

203.03.08 Surplus Material. Unless otherwise specified in the contract documents, surplus excavated material shall be used to widen embankments uniformly, or to flatten slopes, or at other locations, all in a manner satisfactory to the Engineer. No surplus material shall be disposed

of above the grade of the adjacent roadbed nor shall the Contractor waste any material unless approved in writing by the Engineer.

If the quantity of surplus material is specified in the contract documents, such quantity shall be considered approximate only. The Contractor shall satisfy himself that there is sufficient material available for the completion of the embankments within the areas involved before disposing of any indicated surplus material inside or outside the right of way. Any shortage of material caused by premature disposal of the indicated surplus material by the Contractor shall be replaced by him and no compensation will be allowed the Contractor for such replacement.

203.03.09 Selected Material. When specified in the contract documents, or when selected by the Engineer, suitable selected material encountered in excavating or widening the roadway prism or any other excavation within the highway right of way, or in the excavation or borrow, shall be used for finishing the top portion of the subgrade.

Selected material shall be defined as material which is excavated from one or more of the above sources and which is used for selective purposes.

When practicable, selected material shall be hauled directly from excavation to its final position on the roadbed and compacted in place, and such work shall be paid for at the contract unit price for the excavation item involved and overhaul if applicable, as set forth elsewhere in these specifications, and no additional compensation will be made. Attention is directed to subsection 104.05, "Rights in and Use of Materials Found on the Work."

When the transporting of selected material directly from excavation to its final position on the roadway is impractical, the selected material shall be left in place until it can be placed in final position and no additional compensation will be made because of the delayed excavation. If, however, the conditions are such that the undisturbed selected material will hamper ordinary grading operations or cause unnecessary movements of equipment, the Engineer may order in writing the removal of sufficient selected materials

and the stockpiling thereof to enable practical hauling operations. If the excavation and stockpiling of selected material is specified in the contract documents or is ordered by the Engineer the excavation shall be from, and the stockpiling at, locations designated by the Engineer. The selected material shall be removed from the stockpile and placed in final position on the roadbed when approved by the Engineer.

Measurement for payment of selected material stockpiled as above provided will be in accordance with subsection 203.04.01(d), "Selected Material."

203.03.10 Slides and Slipouts. Material outside the planned roadway or ditch slopes which is unstable and constitutes potential slides in the opinion of the Engineer, material from slides which has come into the roadway or ditch, and material which has slipped out of new or old embankments shall be excavated and removed. The material shall be excavated to designated lines or slopes either by benching or in such manner as approved by the Engineer. Such material shall be used in the construction of the embankments or disposed of as approved by the Engineer.

The above provisions shall not be so construed as to relieve the Contractor from the duty of maintaining all slopes true and smooth. Erosion, regardless of amount or extent, caused by the action of the elements which results in damage to work or materials, shall in no case be considered a slide or slipout. Measurement for payment will be in accordance with subsection 203.04.01(f), "Slides and Slipouts."

203.03.11 Drainage. During construction of the roadway, the roadbed shall be maintained in such condition that it will be well drained at all times.

V-type ditches shall be formed to the cross section and dimensions on the plans by means of suitable equipment which will deposit all loose material on the downhill side so that the bottom of the finished ditches shall not be less than two (2) feet six (6) inches below the crest of the loose material piled on the downhill side.

In going from cut to fill, the roadway ditches shall be

cut to the right or left before reaching the fill so as to avoid damage to embankments by erosion.

The flat-bottom ditches indicated on the plans, or staked by the Engineer, shall be excavated to the required cross section and grade. Materials so obtained shall be used to construct roadway embankments or dikes or both to form a continuous diversion channel as staked by the Engineer.

203.03.12 Channels. To avoid destruction of natural growth during construction of ditches, channels, or dikes, travel of equipment shall be confined to the construction limits as nearly as practicable. Where ditches, channels, or dikes are nearly parallel to the roadway, turn-arounds shall not be located closer than two hundred (200) feet apart. Attention is directed to subsection 107.12, "Protection and Restoration of Property and Landscape."

Fine grading of channel bottoms will not be required unless paving is specified.

203.03.13 Borrow. A possible source of borrow material may be indicated in the contract documents. If the Contractor desires to use borrow materials from sources other than those described in the contract documents, he shall, at his own expense, acquire the necessary right to take materials and pay all costs involved. All costs of exploring such alternate sources shall be borne by the Contractor. Use of material from these sources will not be permitted until approved in writing by the Engineer.

The successful bidder shall, at the time of execution of the contract, execute an "Agreement" for all borrow deposits obtained under an "Option and Agreement for Sale of Materials" when said "Option" is contained in the special provisions. This agreement shall be executed whether the material is to be used or not.

In case designated borrow deposits fail to contain the necessary quantity of acceptable material, the Contractor shall immediately notify the Engineer in writing. The Engineer shall thereupon investigate, and if his investigation shows that there is not a sufficient quantity of acceptable material, he shall designate an alternate deposit in which to obtain the deficit.

Overhaul on borrow will be measured for payment in accordance with subsection 203.04.01(g), "Overhaul" and Section 205, "Overhaul."

In all borrow pits having undesirable material, including overburden, refuse, organic and deleterious substances, the material shall be removed and wasted or redistributed, in a manner satisfactory to the Engineer. All costs incurred therefor shall be considered as incidental and subsidiary to the borrow and no further compensation will be made for undesirable materials removed.

Borrow shall not be obtained until all other excavation items are complete to the extent necessary to determine the need for borrow.

The Contractor shall notify the Engineer sufficiently in advance of opening any borrow areas so that cross section elevations and measurements of the ground surface after stripping may be taken, and the borrow materials can be tested before being used. Sufficient time for testing the borrow shall be allowed.

Borrow deposits shall be excavated to regular lines as staked to permit accurate measurement. The dimensions of the borrow deposit will be designated and the Contractor shall not excavate below the depth or outside limits given except with prior approval. The depth of excavation throughout the area of the borrow pits shall be as uniform as practicable and the side slopes shall conform to the requirements of subsection 104.06, "Final Clean Up." Unless otherwise permitted, borrow pits shall be excavated so that they will drain to the nearest natural outlet.

All materials which are not satisfactory for use for the purposes intended shall be rejected at the pit and disposed of in a manner satisfactory to the Engineer.

If the Contractor excavates more material than is required, the excess will not be measured for payment.

All work and materials required to build and maintain borrow haul roads and obliteration of haul roads in accordance with subsection 104.06, "Final Clean Up" shall be considered subsidiary to the "borrow" item and no further compensation will be allowed therefor.

203.03.14 Foundation. When embankment is to be placed and compacted on hillsides, or when new embankment is to be compacted against existing embankments, or when embankment is to be built one half width at a time, the slopes that are steeper than four to one (4:1) when measured at right angles to the roadway shall be continuously benched as the work is brought up in layers. Benching shall be of sufficient width to permit operations of placing and compacting equipment. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cuts. Material thus cut out shall be recompacted along with the new embankment material at the Contractor's expense, unless the width of excavation required by the Engineer exceeds six (6) feet, in which case the excavated material in excess of six (6) feet will be measured and paid for as roadway excavation.

All foundations for embankment shall be cleared and grubbed in accordance with Section 201, "Clearing and Grubbing."

In designated areas, unsuitable material shall be removed and disposed of as prescribed in subsection 203.-03.02, "Unsuitable Material."

Where twelve (12) inches or less of embankment is placed over existing bituminous surface, such surface shall be removed and incorporated in the embankment or otherwise disposed of as approved by the Engineer. Where more than twelve (12) inches of embankment is placed over existing bituminous surface, such surface shall be left undisturbed. Measurement for removal of existing bituminous material will be as prescribed in subsection 203.04.01, "Measurement," and paid for as roadway excavation unless the contract documents specifically call for payment under Section 202, "Removal of Structures and Obstructions."

203.03.15 Embankment Material. Embankments shall be constructed with suitable materials, excavated as prescribed and with any excess materials from other operations which are acceptable and suitable for use.

All materials used in embankments shall be free from objectionable material such as leaves, grass, roots, logs, stumps, brush, or other perishable material.

When there is a choice of material and when practicable, the excavation shall be made so the best material will be placed on top of the embankment for at least one (1) foot in depth. This paragraph shall not be interpreted as to require the Contractor to stockpile and subsequently rehandle embankment materials except as provided in subsection 203.03.09, "Selected Material."

Material shall not be placed in the embankment when either the material, foundation or the embankment on which it would be placed is frozen.

Where embankments are to be made of material from rock cuts or other material which is unsuitable for finishing the roadbed, the upper six (6) inches of the roadbed shall be formed of approved material.

203.03.16 Placing Embankment. For embankment or backfill deposited against structures, attention is directed to subsection 207.03.02, "Placing and Compacting at Abutments, Piers, Wingwalls, and Retaining Walls."

Where structure abutments are placed on embankment, the embankment shall be constructed to subgrade elevation prior to excavating for the construction of the abutment. Structure excavation shall be measured for payment as set forth in subsection 206.04.01, "Measurement." Where the abutment is supported on piles, the embankment shall be constructed to the elevation of the bottom of the footing.

Where structures are located under a rock embankment, they shall be covered with not less than two (2) feet of satisfactory soil or granular materials before the embankment is placed over the structure.

Embankments shall, except as hereinafter specified, be constructed in layers. The construction of an embankment shall begin at the lowest point of the fill below the grade and the bottom of ravines. Individual layers shall be spread evenly to uniform thickness throughout and parallel with the finished grade for the full width of the embankment, unless otherwise permitted. The thickness of the

layer shall be as necessary to secure the required compaction with an eight (8) inch maximum thickness before compaction. Excepted provisions are hereinafter outlined for placing in marsh and placement of rock.

Where embankments are to be constructed across low swampy ground, which will not support the weight of the hauling equipment, the lower part of the embankment may be constructed by end dumping to form a uniform layer of a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers. The remainder of such embankments shall be constructed in layers and compacted as herein specified.

Embankment which, in the opinion of the Engineer, contains a sufficient quantity of rock larger than four (4) inches in size shall be considered as "Rock Embankment." The materials shall be spread in a uniform horizontal layer over the full width of the embankment. The layer thickness shall not exceed one and one-third (1⅓) times the vertical dimension of maximum size material larger than eight (8) inches. The largest size rock allowed in the embankment will be three (3) feet measured in vertical direction and rocks larger than this shall be broken up before being placed in the embankment. Rock to be wasted may exceed three (3) feet and be disposed of in an inconspicuous manner approved by the Engineer.

In rock fills where end dumping is employed, direct end dumping upon the previously constructed layer of embankment will not be permitted. Rock shall be dumped on the layer of embankment being constructed and dozed ahead into place. Care shall be exercised as much as practicable to work the fines and smaller rock into the spaces between the larger rock. Compaction will be required as provided in subsection 203.03.18, "Compaction, Rock Embankment."

To the extent of project requirements for embankment, all rock from excavation shall be used for embankment. The Contractor shall plan his grading operation to use rock which may be encountered in excavation in accordance with the following provisions:

Rock, in general, shall be placed so as to form the base

of embankment for the full width of the cross section; on the side slopes or slopes of a new embankment being placed; on the side slopes or slopes of an embankment already in place requiring widening or where excess rock may be wasted; or on the side slopes and top of rolled embankment made of embankment materials other than rock.

The Contractor shall not place large rock in embankments where piles will be driven. The Contractor shall be responsible for penetrating the embankment with specified piles.

When rock and other embankment materials are excavated at approximately the same time, the rock shall be distributed throughout the fill and not nested in one location.

When there is insufficient material other than rock in the excavation to permit properly compacted layers, the rock shall be placed for the full cross-section width with the larger rocks well distributed and the void spaces filled with the smaller rocks and fragments.

When shown on the plans or considered necessary by the Engineer, embankments shall be built to such elevation above required grade to allow for settlement, or sufficient surcharge shall be placed above the required elevation of earth grade over deposits of unstable material to secure displacement or settlement. Surcharge shall be removed only after the fill has reached stability or the required settlement.

203.03.17 Compaction, Dirt Embankment. Optimum moisture content of the various soils will be determined by the Engineer and the information will be given to the Contractor so he may attain the required density with the most economical compactive effort. At the time of compaction, the moisture content of embankment material shall be such that the specified relative compaction will be obtained. Embankment material which contains excessive moisture shall not be compacted until the material is dry

enough to obtain the required compaction. Full compensation for any additional work involved in drying embankment material to the required moisture content shall be considered as included in the contract price paid for excavating or furnishing the material and no additional compensation will be allowed therefor.

The base of cuts, natural ground having less than five (5) feet of embankment, measured from the subgrade, and embankment material, shall be compacted to ninety (90) percent of the relative maximum density as determined by Test Method No. Nev. T102 or an equivalent density as determined by Test Method No. Nev. T101. Test method to be determined by the Engineer. When natural ground material is encountered that cannot be compacted to the required density, compaction requirements shall be determined by the Engineer.

Where decks of reinforced concrete boxes and bridges are three (3) feet or less below profile grade, all "Structure Backfill" and roadway embankment material placed within one hundred (100) feet of the structure shall be compacted to not less than ninety-five (95) percent of the relative maximum density in accordance with the above test methods. Each side of structure shall be considered separately.

It is to be expected that a loss of density in the upper portion of earth subgrade may occur due to the elements, or for lapse of time, or for other reasons. Recompaction to the specified density will be required prior to placement of any subsequent course and no additional compensation will be allowed therefor.

203.03.18 Compaction, Rock Embankment. Field density tests will not be required on rock embankment. In lieu thereof, the required compaction shall be tested by proof rolling. In this case, compaction shall be attained and tested by using construction methods and equipment as follows:

(a) Methods. The material for the embankment shall be deposited, spread and leveled the full width of the embankment, and in layers not exceeding eight (8) inches

in thickness before compaction, except large rock fills in which the layer thickness may be one and one-third (1⅓) times the vertical dimension of maximum size material. The maximum layer thickness shall not exceed four (4) feet.

Hauling and leveling equipment shall be routed and distributed over each layer of the fill in such a manner as to make use of the compaction afforded thereby. In addition, one of the rollers, vibrators, or compactors meeting the requirements set forth under (b) "Equipment" below, shall compact the embankment full width with a minimum of three (3) complete passes for each layer of embankment. The compacting equipment shall not exceed a speed of five (5) miles per hour and shall work continuously with the grading equipment.

Rolling shall be done in a longitudinal direction along the embankment and shall generally begin at the outer edges and progress toward the center. The travel paths of traffic and construction equipment shall be kept dispersed over the entire width of the embankment so as to aid in obtaining uniform compaction. Weights of equipment used in making embankments over soil having an excessive moisture content may be limited, if, in the judgment of the Engineer, such limitations are necessary in order to maintain the fill in a satisfatory condition.

Water shall be applied to the embankment in the amount necessary to obtain the required compaction.

(b) Equipment. Compaction equipment shall be adequately designed to obtain compaction requirements without adverse shoving, rutting, displacement, or loosening and shall meet the requirements hereinafter specified. Rollers shall have displayed thereon in permanent legible characters, the manufacturer's guaranteed net operating weights as distributed on each axle.

Sheepsfoot or tamping rollers shall consist of metal drums or shells, not less than four (4) feet in diameter, equipped with self-cleaning tamping feet projecting at least seven (7) inches from the face of the drum or shell. The cross-sectional area of the face of each tamping foot shall be not less than four (4) nor more than twelve (12) square

inches. The feet shall be uniformly spaced on the roller. The weight and dimensions of the roller, the number, spacing, and dimensions of the tamping feet and the provisions for adding ballast, shall be such that the total load on a single row of the tamping feet in contact with a level surface can be made as great as two hundred (200) pounds per inch of length of roller drum. The weight shall be adjusted to that which will produce the specified density with the least number of passes. Tamping rollers shall make at least three (3) complete coverages of the material being compacted and rolling shall continue until the tamping feet "build up" or "walk out" of the surface.

Grid rollers shall consist of at least two similar metal drums, not less than five (5) feet in diameter, whose cylindrical faces present the appearance of an open woven bar mesh. The drums shall be at least two and one-half (2½) feet long and they shall be independently mounted close together on the same axle. The complete roller, when operating without ballast, shall weigh not over six (6) tons or two hundred (200) pounds per inch of length of roller drum. Arrangements shall be provided for adding ballast, to such an extent that the total weight of the unit can be increased to at least fifteen (15) tons and four hundred fifty (450) pounds per inch of length of roller drum.

Pneumatic tired rollers shall be of an approved, self-propelled, reversible type and shall have not less than seven (7) wheels mounting pneumatic tires of equal size which may be either treaded or smooth faced, but which shall all be alike. Wheels shall be equally spaced along both axle lines so that their center to center distance is not greater than one and seven-eighths (1⅞) times the nominal tire width and they shall be arranged so that those on one axle track midway between those on the other. Tires shall be capable of operating at inflation pressures up to one hundred twenty (120) pounds per square inch. They shall be kept uniformly inflated at whatever operating pressure is specified so that the difference between the pressure in any two tires shall never exceed five (5) pounds per square inch. The Contractor shall provide means for checking the tire pressure on the job at any

time. For each size and type of tire used, the Contractor shall furnish the Engineer a copy of the tire manufacturer's chart showing the internal volume of the tire as well as the relationship between wheel load, inflation pressure and tire contact width and area. The roller shall be equipped with a means of adjusting its total weight by ballasting so that the load per wheel can be varied from three thousand five hundred (3,500) to eight thousand (8,000) pounds. The Contractor shall furnish the Engineer a copy of the roller manufacturer's calibration chart for the ballast box showing the empty or tare weight of the roller. In operating, the tire inflation pressure and the wheel loads shall be adjusted, as required to meet the requirements of each particular application and of the material being rolled. On the axle having an even number of wheels, the wheels shall be arranged to oscillate in pairs or they may be individually sprung. The roller shall be equipped with dual operating controls, power steering and some type of fluid drive or torque converter.

Pneumatic tired rollers meeting the requirements of the proof roller may be used in lieu of those specified above.

Pneumatic tired compactors shall have not less than four (4) wheels abreast on the line of the main axle. The compactor shall be so articulated or shall have pairs of wheels mounted on oscillating axles in such a manner as to insure that a constant and uniform load is carried by each wheel. Wheels shall be uniformly spaced along axle lines so that their center to center distance is not greater than one and three-fourths (1¾) times the nominal tire width. If there is more than one line of axles, then the wheels on each line shall be spaced the same distance apart and shall be so aligned that the wheels on one axle will track midway between those on the other. All tires shall be of equal size and diameter and shall be capable of operating at an air pressure of at least ninety (90) pounds per square inch. They shall be kept uniformly inflated so that the difference in the pressure in any two tires shall never exceed five (5) pounds per square inch and means shall be provided for checking the tire pressure on the job at any time. For each size and type of tire used, the Contractor shall furnish the

Engineer a copy of the tire manufacturer's chart showing the internal volume of the tire as well as the relationship between wheel load, tire inflation pressure and tire contact width and area. When operating light, no wheel on any axle shall carry a load of more than five thousand (5,000) pounds. Means shall be provided for adding sufficient ballast so that each wheel may be loaded to at least twenty-five thousand (25,000) pounds. In addition, the compactor shall be capable of applying to the ground, loads as great as fifty (50) tons and twelve hundred (1,200) pounds per linear inch on nominal tire width, measured along an axle line. The weight of the compactor and the air pressure in the tire shall be adjusted to that which will produce the specified density with the least number of passes without exceeding the shear value of the soil. The Contractor shall furnish the Engineer with a copy of the roller manufacturer's calibration chart for the ballast box showing the volume of the box, in cubic feet, for at least three (3) inch increment of depth and also showing the empty or tare weight of the roller. Compactors shall make at least two (2) complete coverages of each layer of material being compacted or at least four (4) coverages in the cases of compactors having only a single line of axles. The compactor, together with its towing unit, if any, shall be capable of making a one hundred eighty (180) degree turn in a width of not over thirty (30) feet.

Vibratory compactors shall not be used until approved by the Engineer.

The proof roller shall be a pneumatic tired roller or pneumatic tired compactor weighing not less than fifty (50) tons and capable of applying to the ground loads of not less than twenty-five thousand (25,000) pounds per wheel. All tires shall be of equal size and diameter and shall be capable of operating at an air pressure of at least ninety (90) pounds per square inch. They shall be kept uniformly inflated so that the difference in the pressures in any two tires shall never exceed five (5) pounds per square inch and means shall be provided by the Contractor for checking the tire pressure on the job at any time.

(c) Tests. Subsequent layers shall not be placed until the previous layer of the embankment is compacted to the

degree that no further appreciable deflection is evidenced under the action of proof rolling equipment, as determined by the Engineer.

Rolling and proof rolling may be deleted on any layer or portion thereof when, in the judgment of the Engineer, accomplishment is physically impractical.

Payment for rolling and proof rolling or for the correction of any subgrade weakness or deficiencies disclosed by the proof rolling operation shall be considered subsidiary to the price bid for the "Excavation" item.

203.03.19 Maintenance. Embankment material which may be lost or displaced as a result of natural settlement of the ground or foundation upon which the embankment is constructed shall be replaced by the Contractor with acceptable material from excavation or borrow, etc. The quantity of material required will be paid for at the regular contract price for the type of materials used, also overhaul, if applicable, and no additional compensation will be allowed therefor.

The Contractor shall, at his expense, remove and replace with acceptable material, any embankment or portion thereof which has been constructed with unapproved material as well as remove and replace portions of the embankment which may become unstable or displaced as the result of carelessness or negligence on his part.

METHOD OF MEASUREMENT

203.04.01 Measurement. Unless otherwise specified, excavation will be measured on a volume basis by cross sectioning the area to be excavated and computing neat lines for an end area. The average end area method will be used with no allowance made for curvature. If for any reason it is impossible or impractical to measure quantities by average end areas, the Engineer will compute the quantities by a method which, in his opinion, is best suited to obtain an accurate determination.

The quantity of excavation to be measured for payment will be the number of cubic yards excavated and placed as required. The estimated quantities shown on the plans, plus or minus authorized quantity changes will be the

quantity used for payment. The State or the Contractor may, however, request a final measurement in which case final cross sections will be taken. When final cross sections are taken the determination of quantities derived therefrom will be the quantities used for payment. Furthermore, when the Contractor requests final measurement and the quantities thus determined are less than the planned quantities plus authorized changes, the Contractor shall reimburse the State for the State's expenses incurred by such final measurement.

When changes are made during construction such as widening cuts, changing grades, disposing of unsuitable material, stockpiling selected material, and other changes resulting in increases or decreases in quantities, then additional measurements for payment will be made by the Engineer as hereinafter outlined:

(a) Unsuitable Material. When the removal and disposal of unsuitable material is shown in the contract documents, such material will be measured for payment as excavation for the related item.

Removal and disposal of unsuitable material, not shown on the plans, will be measured and paid for as "Roadway Excavation" and "Overhaul." However, if removal and disposal of unsuitable material not shown on the plans requires special equipment or unusual operations, it may be paid for as extra work according to the provisions of subsection 104.03, "Extra Work."

No measurement will be made of suitable material temporarily removed and replaced to facilitate compaction of material.

(b) Overbreak. All sideslope overbreak as defined in subsection 203.03.05, "Overbreak," shall not be paid for.

Rock removed to a maximum depth of six (6) inches below subgrade will be measured for payment provided the rock has been removed sufficiently to permit accurate cross sectioning. Replacement to this depth shall be with material designated on the plans or approved by the Engineer and will be measured and paid for at the contract unit price for the material used.

Rock loosened or removed in excess of six (6) inches below subgrade will not be measured nor paid for. When

ordered by the Engineer, the loosened material will be removed and the resultant space refilled with approved material at the expense of the Contractor.

(c) Widening Cuts. If the Engineer directs the Contractor to excavate beyond the limits of the typical cross section and before the excavation is substantially completed, the material shall be classified as "Roadway Excavation" and shall be paid for at the contract bid price. However, if widening cuts requires special equipment, or unusual and extra expense, it may be paid for as extra work according to the provisions of subsection 104.03, "Extra Work."

(d) Selected Material. Selected material stockpiled as provided in subsection 203.03.09, "Selected Material" will be measured for payment as roadway excavation both in its original position and also from the stockpile. Measurement of the material taken from stockpile will be made of the volume actually removed.

(e) Surplus Material. Surplus excavated material will be measured for payment as roadway excavation and no further compensation will be allowed by virtue of the method of disposing, placing, or widening embankments caused from such surplus material. Any additional "Overhaul" resulting from the disposal of surplus material beyond the designated balance, will be measured for payment.

(f) Slides and Slipouts. In the event of slides and slipouts, the Engineer and Contractor shall negotiate in each case and decide the relative difficulty of performing the work, and payment will be made either as "Roadway Excavation" or as "Extra Work" as provided in subsection 104.03, "Extra Work."

Where slopes have been previously completed by the Contractor, the cost of resloping required in areas where unstable material is removed will be paid for as extra work as provided in subsection 104.03, "Extra Work."

The cost of pioneering work necessary to make slide or slipout areas accessible to normal excavation equipment and the cost of necessary clearing and grubbing will be paid for as extra work as provided in subsection 104.03, "Extra Work."

Only those quantities of slide or slipout material which are authorized and actually removed will be measured for payment.

(g) Overhaul. Overhaul, where applicable, will be paid for on the above items of excavations. Overhaul on borrow material from sources furnished by the Contractor will be paid for according to the actual amount of overhaul from the sources from which the borrow is taken, provided, however, that no allowance will be made for overhaul from such sources in excess of overhaul distance computed from the sources designated. Attention is directed to Section 205, "Overhaul."

Excavation in excess of the staked or authorized cross section will not be measured for payment, except as outlined above.

Material used for surcharge, whether shown on the plans or called for by the Engineer, will be measured for payment as roadway excavation both in its original position and also from the surcharge position.

Earthwork quantities within the limits of "Slope Rounding" will not be measured for payment.

V-type ditches will be measured parallel to the ground and each one hundred (100) linear feet shall constitute a unit of measure. The volume of excavation for such ditches will not be measured for payment.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

203.05.01 Payment. The accepted quantities of excavation measured as specified in subsection 203.04.01, "Measurement," will be paid for at the contract unit price bid for each of the pay items listed in the bid schedule. Such price shall include excavating, loading, hauling (except overhaul), depositing, spreading, compacting, and maintaining the material complete and in place. Watering will be paid for in accordance with Section 210, "Watering."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Roadway Excavation	Cubic Yard
Drainage Excavation	Cubic Yard
Channel Excavation	Cubic Yard
Borrow Excavation	Cubic Yard
V-type Ditches	Stations

SECTION 204

ROUNDED AND TRANSITION SLOPES

DESCRIPTION

204.01.01 General. This work shall consist of rounding and shaping slopes in accordance with the plans and where designated by the Engineer.

CONSTRUCTION

204.03.01 General. The top of cut slopes shall be rounded by excavating to blend the cut slopes with the adjacent natural terrain. At the intersection of cuts and fills, slopes shall be adjusted and warped to blend into each other or into the natural ground surface without noticeable break.

Slopes will be staked for flattening and rounding in places where the material is other than solid rock. Rock formations such as shales, decomposed sandstone and granite that can be readily excavated by means of hand tools, shall have the slopes flattened and rounded the same as earth slopes. A layer of earth overlying a rock cut shall be rounded above the rock the same as earth slopes. Where the depth of cut is insufficient to provide the full rounding required, the distance for rounding shall be proportionately adjusted.

Slope rounding and warping shall also apply to all drainage ditches when such rounding will improve the appearance of the roadside.

Whenever the treatment of the slopes may destroy or injure standing timber, trees or other vegetation which should be preserved, adjustments in slope grading will be made. These adjustments shall be effected by a gradual transition from the theoretical grading section required.

The degree of smoothness required in rounding and warping slopes shall be as specified in subsection 203.-03.06, "Slopes."

METHOD OF MEASUREMENT

204.04.01 Measurement. The quantity of rounded or transition slope to be measured for payment will be the number of linear feet of slopes, measured along the roadway ditch each side of the roadway centerline, and each one hundred (100) feet shall constitute the unit of one station. Rounding of shoulders or bottoms of side ditches when required, shall not be measured for payment. Earthwork quantities within the limits of "Slope Rounding" will not be measured for payment.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

204.05.01 Payment. The accepted quantity of slope rounding measured as specified in subsection 204.04.01, "Measurement," will be paid for at the contract unit price bid per station of the completed work.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Slope Rounding	Stations

SECTION 205

OVERHAUL

DESCRIPTION

205.01.01 General. This work shall consist of authorized hauling of roadway excavation, channel excavation, and borrow in excess of the free-haul distance.

Free-haul distance is the specified distance that excavated material shall be hauled without additional compensation. Unless otherwise provided in the contract documents, the free-haul distance shall be two thousand (2,000) feet.

METHOD OF MEASUREMENT

205.04.01 Measurement. The limit of free haul shall be determined from a mass diagram by fixing on the volume curve, two points, one on each side of the neutral grade point, one in excavation and the other in embankment, such that the distance between them equals the free-haul distance, and the included quantity of excavation and embankment are in balance. All materials within the free-haul limit shall be eliminated from further consideration. The distance between the center of gravity of the remaining mass of excavation and the remaining mass of embankment minus the free-haul distance shall be the overhaul distance. The quantity of overhaul shall be the product of the overhaul distance measured in miles multiplied by the number of cubic yards of material hauled in excess of the free-haul distance. Analytical methods may be used for computing overhaul in lieu of the mass diagram method described herein.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

205.05.01 Payment. The accepted quantities of overhaul measured as specified in subsection 205.04.01,

"Measurement" will be paid for at the contract unit price bid per yard mile of the completed work.

When overhaul does not appear as an item in the proposal, the contract unit price bid per cubic yard for roadway excavation, borrow excavation, and channel excavation shall be considered as including payment for overhaul.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Overhaul	Yard Mile

SECTION 206

STRUCTURE EXCAVATION

DESCRIPTION

206.01.01 General. This work shall consist of the removal of all material of whatever nature encountered for the construction of foundations for bridges, retaining walls, headwalls for culverts and other structures; the excavation of trenches for pipe and box culverts, cut-off walls for slope paving and concrete aprons, footings for riprap and other excavation specifically designated on the plans, in these specifications or in the special provisions as structure excavation, including the work of disposing of surplus material and cleaning up the sites. Structure excavation shall include dewatering and the furnishing of all equipment and the construction or installation of all cofferdams, cribs, and other facilities which may be necessary to perform the excavations and the subsequent removal of such facilities except where they are required or permitted by the plans or specifications to remain in place. It shall also include all the necessary clearing and grubbing within the proposed structure area and removing old structures or parts thereof as required if the proposal does not include separate bid items for such work.

For specific requirements pertaining to the excavation involved in the installation of pipe culverts and underground piping, attention is directed to those sections of these specifications governing such work.

206.01.02 Classification. Classification of structure excavation will not be made on the basis of materials or conditions encountered. Classification of excavation, if made, will be on the basis of the material removed between certain elevations, and such classification as shown on the plans or set forth in the special provisions shall not be changed regardless of the material encountered.

CONSTRUCTION

206.03.01 General. The Contractor shall notify the Engineer a sufficient time in advance of the beginning of excavation for structures so that elevations and measurements may be taken of the existing ground before it is disturbed and of existing substructure units within the limits of excavation for structures before they are removed. Any material excavated or removed before these measurements have been taken will not be paid for.

The excavated area shall conform to the outlines of the footings, as shown on the plans, and shall be of sufficient size to permit placing of the full width and length of the footings shown. The elevation of the bottoms of footings as shown on the plans shall be considered as approximate only, and the Engineer may order, in writing, such changes in dimensions or elevation of footings as may be necessary to secure a satisfactory foundation.

Unless otherwise permitted by the Engineer, foundations for culvert pipe and structures shall be compacted to ninety (90) percent of relative maximum density as determined by Test Method No. Nev. T101 or T102. Test method to be determined by the Engineer.

All rock or other hard foundation material shall be freed from all loose material, cleaned and cut to a firm surface, either level, stepped or serrated, as may be permitted by the Engineer. All seams and crevices shall be cleaned out and filled with concrete mortar or grout.

Where masonry is to rest on material other than rock or boulders, special care must be given not to destroy its bearing value.

Should the Contractor remove foundation excavation below grade, he shall backfill to the required elevation at his own expense with backfill or with foundation fill in a manner satisfactory to the Engineer.

Wet pits shall be unwatered for inspection and for construction of foundations unless otherwise provided.

Excavated material which is suitable for backfilling shall be so utilized or used in embankments, in a manner satisfactory to the Engineer. Surplus or unsuitable material shall be disposed of so as to cause no obstruction to flow

of streams; or otherwise impair the efficiency or appearance of the structure. It shall be disposed of in such manner as to prevent damage to property or the creation of unsightly conditions, and shall not be placed where it will interfere with the operation of drains or impair the roadway ditches, etc.

206.03.02 Inspection. After each excavation is completed, the Contractor shall notify the Engineer, and no masonry shall be placed until the Engineer has approved the depth of excavation and the character of the foundation material.

METHOD OF MEASUREMENT

206.04.01 Measurement. The quantity of structure excavation measured for payment will be the number of cubic yards calculated and shown on the plans, plus or minus quantities covered by approved changes. The Engineer or the Contractor may request recalculation if a possible error is suspected in the quantities shown on the plans. If the Contractor requests recalculation of quantities, such request shall be in writing. When quantities are recalculated, the quantities derived therefrom will be the quantities used for payment. All calculations will be made according to the dimensions shown on the standard sheets appended to the plans. Only those quantities complete and in place will be measured for payment.

The yardage of water or any other liquid will not be included in the measurement for payment, except that the yardage of mud, muck, or similar semi-solid matter not resulting from construction operations and which cannot be pumped or drained away shall be included.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

206.05.01 Payment. The accepted quantity of structure excavation measured as provided in subsection 206.-04.01, "Measurement" will be paid for at the contract unit price bid per cubic yard, which payment will be

full compensation for clearing, grubbing, cofferdams, cribs, sheeting, shoring, bracing, pumping, unwatering, and disposing of all materials.

No compensation will be made for the removal and disposal of material which may come into an excavation from outside the designated limits or for the removal and disposal of swell material resulting from the driving of piles in an excavation.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Structure Excavation	Cubic Yard

SECTION 207

BACKFILL

DESCRIPTION

207.01.01 General. This work shall consist of placing and compacting, to the lines designated on the plans or as established by the Engineer, backfill or granular backfill material in excavations for bridges, retaining walls, headwalls for culverts, and other structures; placing and compacting backfill or granular backfill material in trenches for culverts and pipes; and other backfill specifically designated in the contract documents as structure backfill. This item does not include backfilling minor miscellaneous structure excavations outside the limits of the roadway.

When the terms "backfill" or "structure backfill" are used herein, they shall be construed to mean backfill or granular backfill, or both.

MATERIALS

207.02.01 Backfill. Material used for backfill shall be of a quality acceptable to the Engineer. The backfill material shall be free from stones or lumps of material exceeding three (3) inches in greatest dimension and shall be free from sod, frozen earth, and organic materials. Acceptable material from excavation may be used for backfilling unless granular backfill is specified and the material from excavation does not conform to the requirements therefor.

207.02.02 Granular Backfill. Material used for granular backfill shall consist of natural sand or a mixture of sand with gravel, crushed gravel, crushed stone, or other broken or fragmented material to fill the voids in the coarser material. In addition thereto, the material shall conform to the following requirements:

Sieve Sizes	Percentage by Weight Passing
3"	100
No. 4	35–100
No. 200	0–15

The liquid limit of the material shall not be greater than twenty-five (25), and the plasticity index shall not be more than six (6).

CONSTRUCTION

207.03.01 General. Compaction of backfill or embankment around all structures shall be secured with mechanical tamping units and the material shall be placed at a rate which will permit efficient use of mechanical tampers in securing the required compaction.

Unless otherwise permitted by the Engineer, foundations for culvert pipe and structures, shall be compacted to ninety (90) percent of the relative maximum density as determined by test methods hereinafter described.

Backfill material shall be placed in uniform horizontal layers not exceeding eight (8) inches in loose thickness before compaction and shall be brought up uniformly on all sides of the structure or improvement. Each layer of backfill shall be moistened as necessary and thoroughly tamped until ninety (90) percent of the relative maximum density is achieved as determined by Test Method No. Nev. T101 or T102. Test method to be determined by the Engineer. Attention is directed to subsection 203.03.17, "Compaction, Dirt Embankment."

Compaction of backfill material by ponding or jetting will not be permitted.

Material resulting from structure excavation and not used as structure backfill shall be deposited in roadway embankments in accordance with the requirements specified elsewhere or otherwise disposed of along the roadway in a manner approved by the Engineer and no additional compensation will be allowed for such work.

Structure backfill shall not be placed until the structure or facilities have been inspected by the Engineer and approved for backfilling. Backfill material shall not be deposited against the back of concrete abutments, concrete retaining walls or the outside walls of concrete box culverts until the concrete has reached an age of fourteen (14) days or the concrete has developed a strength of two thousand five hundred (2,500) pounds per square inch in compression as determined by Test Method No. Nev. T475.

Where backfill is placed against waterproofed surfaces, care shall be taken that no damage is done to the waterproofing material.

207.03.02 Placing and Compacting at Abutments, Piers, Wingwalls and Retaining Walls. With the approval of the Engineer, all spaces excavated and not occupied by abutments, piers, or other permanent work shall be refilled with earth up to the surface of the surrounding ground or to the limits designated on the plans or as described herein. All backfill shall be thoroughly compacted in accordance with the provisions set forth in subsection 207.03.01, "General."

Where backfill is to be placed on one side of an abutment, wingwall, pier, or headwall, care shall be exercised to prevent over compacting to the point of displacing line or batter or both.

Existing slopes which are shaped so as to cause a wedge action in the backfill, shall be step-cut or benched before backfilling.

207.03.03 Placing and Compacting at Culverts. After the bedding has been prepared and the culverts installed or constructed as required by the pertinent specifications, acceptable material from excavation or from other sources shall be placed along both sides of the culvert equally in uniform layers not exceeding eight (8) inches in depth (loose measurements), wetted as required and thoroughly compacted to the density requirements as set forth in subsection 207.03.01, "General."

Special care shall be taken in placing and thoroughly compacting the material under the haunches of all pipe.

Unless otherwise directed, the backfilling shall continue as described to the level of the ground or to an elevation six (6) inches above the structure in the case of a pipe culvert in projection, or even with the top of the structure in the case of an RCB culvert in projection.

No construction or other traffic shall be permitted to cross any culvert until a safe minimum depth of fill above the culvert has been placed and consolidated in accordance with these specifications. The Contractor shall be solely

responsible for protecting the structure from superimposed loading created by construction equipment or otherwise and shall repair any damage done to the structure or replace the structure as ordered without extra compensation.

Special care shall be taken in backfilling arches, particularly half-circle arches. The arch shall be covered in layers, each layer conforming to the shape of the arch and tamped thoroughly.

207.03.04 Placing and Compacting of Bin-Type Retaining Walls. Placing and compacting backfill material for bin-type retaining walls shall progress concurrently with the assembly of the bins, and backfilling around the outer sides thereof shall be kept approximately level with the inside fills. The materials shall be thoroughly tamped and meet the density requirements as set forth in subsection 207.03.01, "General." Care shall be exercised to completely fill the depressions of stringers and spacers without over compacting to the point of displacing them from established line and batter.

METHOD OF MEASUREMENT

207.04.01 Measurement. The quantity of backfill or granular backfill measured for payment will be the number of cubic yards calculated and shown on the plans, plus or minus quantities covered by approved changes. The Engineer or the Contractor may request recalculation if a possible error is suspected in the quantities shown on the plans. If the Contractor requests recalculation of quantities, such request shall be in writing. When quantities are recalculated, the quantities derived therefrom will be the quantities used for payment. All calculations will be made according to the dimensions shown on the standard sheets appended to the plans. Only those quantities complete and in place will be measured for payment.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

207.05.01 Payment. The accepted quantities of backfill or granular backfill measured as provided in subsection

207.04.01, "Measurement," will be paid at the contract unit price bid per cubic yard for backfill or granular backfill.

When structure excavation is unacceptable as backfill and backfill material is obtained from the roadway prism or from borrow or from base materials, it will be paid for both as backfill and the respective bid item from which it is obtained. When granular backfill is called for it will be paid as granular backfill only and no further compensation will be paid for borrow or base items.

Payment for backfill or granular backfill shall be full compensation for furnishing, hauling, and compacting all material.

When an item for backfill does not appear in the proposal, backfill will be considered as incidental to the installation of the structure and compensation shall be included in the contract prices for other items of the work.

Water applied will be paid for in accordance with Section 210, "Watering."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Backfill	Cubic Yard
Granular Backfill	Cubic Yard

SECTION 208

FOUNDATION FILL

DESCRIPTION

208.01.01 General. This work shall consist of furnishing and placing sand, gravel, rock, or any suitable combination of these materials in areas where unstable foundation materials have been excavated below the foundation elevation for culverts, bridges, and all other structures in accordance with these specifications and in conformity with the grades and elevations shown on the plans or established by the Engineer.

MATERIALS

208.02.01 General. Material shall be as set forth in the special provisions.

CONSTRUCTION

208.03.01 General. Unsatisfactory material shall be removed to the depth required and piles driven if designated. Foundation fill shall be placed to bring the subfoundations to the required elevation.

Compaction of foundation fill shall be secured with mechanical tamping units or other compaction methods approved by the Engineer. Material shall be placed at a rate which will permit efficient use of compaction methods.

Unless otherwise permitted by the Engineer, foundation fill shall be compacted to ninety (90) percent of the relative maximum density as determined by Test Method No. Nev. T101 or T102. Test method to be determined by the Engineer.

Compaction by ponding or jetting will not be permitted.

METHOD OF MEASUREMENT

208.04.01 Measurement. The quantity of foundation fill to be measured for payment will be the number of cubic yards measured in accordance with the dimensions shown on the plans or established by the Engineer.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

208.05.01 Payment. The accepted quantities of foundation fill measured as provided in subsection 208.04.01, "Measurement" will be paid for at the contract unit price bid per cubic yard of foundation fill complete and in place.

Full compensation for furnishing, hauling, placing, and compacting foundation fill shall be considered as included in the contract price paid for foundation fill.

Watering will be paid for in accordance with Section 210, "Watering."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Foundation Fill	Cubic Yard

SECTION 209

DRAIN BACKFILL

DESCRIPTION

209.01.01 General. This work shall consist of furnishing, hauling, placing, and compacting drain backfill material around structures or perforated underdrains to the lines designated on the plans or established by the Engineer.

MATERIALS

209.02.01 General. Material shall conform to the requirements as set forth in subsection 704.03.01, "Drain Backfill."

CONSTRUCTION

209.03.01 Underdrains. The trench shall be excavated and drain backfill placed in accordance with the provisions of Section 607, "Underdrains."

Trenches for blind drains shall be excavated to the width and depth shown on the plans, or established by the Engineer. The trench shall be filled with drain backfill material to the depth required by the plans. Any remaining upper portion of trench shall be filled with either granular or impervious material as may be specified.

Where drain backfill is part of the structural section, it shall be compacted to ninety (90) percent of the relative maximum density as determined by Test Method No. Nev. T101 or T102. Test method to be determined by the Engineer.

Compacting by ponding or jetting will not be permitted.

METHOD OF MEASUREMENT

209.04.01 Measurement. The quantity of drain backfill to be measured for payment will be the number of cubic yards measured in accordance with the dimensions shown in the plans or established by the Engineer complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

209.05.01 Payment. The accepted quantities of drain backfill measured as provided in subsection 209.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard of drain backfill.

Full compensation for furnishing, hauling, placing, and compacting drain backfill shall be considered as included in the contract price paid for drain backfill.

Watering will be paid for in accordance with Section 210, "Watering."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Drain Backfill	Cubic Yard

SECTION 210

WATERING

DESCRIPTION

210.01.01 General. This work shall consist of but is not limited to furnishing, hauling, and applying all water required for compaction of embankment foundation areas, embankments, subgrade, mineral aggregate base and surfacing materials, structure backfill, processing cement treated base or subgrade material, and for laying dust caused by grading operations and traffic.

MATERIALS

210.02.01 General. All materials shall conform to the requirements set forth in Section 722, "Water."

CONSTRUCTION

210.03.01 Equipment. Equipment used for applying water required for compacting embankment materials, subgrade, base and surfacing materials, and for laying dust shall be pressure type distributors equipped with a spray system that will ensure uniform application of water. All the watering equipment used for the application of water shall be equipped with a positive means of shutoff and the use of equipment not so equipped will not be permitted. An approved pump, pipe, hose, and nozzle equipment may be used in embankment construction. Where the head is sufficient to provide equal pressure, the pump requirement may be eliminated.

210.03.02 General. Water for dust control shall be applied in the amounts and on the areas designated by the Engineer.

The Contractor shall apply water in the amount necessary to attain the compaction in those materials requiring a specified density. In certain of the base courses, water shall be introduced into the aggregate at the plant and when necessary to attain the specified compaction, shall be supplemented by additional wetting as specified above.

Excavation areas and borrow pits may be watered prior to excavating material.

When water is applied directly to the roadbed, the material shall be processed by suitable equipment until the layer is uniformly wet. Care shall be taken to avoid disturbing layers which have been previously placed and compacted.

The Contractor shall make all arrangements for providing an adequate water supply. He shall negotiate with owners of supply and sign an agreement with each owner prior to removing the water. A copy of said agreement shall be furnished the Engineer. He shall pay all royalties occurring under such agreements and shall also obtain any necessary right of way.

METHOD OF MEASUREMENT

210.04.01 Measurement. The unit of measure for "Watering" will be lump sum.

BASIS OF PAYMENT

210.05.01 Payment. Watering will be paid for at the contract lump sum price bid, which price shall be full compensation for: developing an adequate water supply, furnishing all necessary equipment for obtaining water from the source or sources, the furnishing of water on the job, and equipment necessary to apply the water in quantities directed by the Engineer.

No adjustment or compensation will be made to the lump sum item of "Watering" for increase or decrease in the quantity of water required, regardless of the reason for such increase or decrease.

When watering does not appear as an item in the proposal, watering shall be considered subsidiary to other items of work and no additional compensation will be allowed therefor.

Partial payments for the item of "Watering" may be made as set forth under subsection 109.06, "Partial Payments."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Watering	Lump Sum

SECTION 211

EROSION CONTROL

DESCRIPTION

211.01.01 General. This work shall consist of preparing slopes, placing and compacting top soil, seeding, fertilizing, jute matting, and mulching all graded and disturbed areas in accordance with these specifications and the details shown in the contract documents.

MATERIALS

211.02.01 General. The materials used shall be those prescribed for the several items which constitute the finished work and shall conform to the applicable requirements of Section 726, "Roadside Materials."

211.02.02 Top Soil. Unless designated in the contract documents, the Contractor shall make his own arrangements for obtaining top soil and he shall pay all costs involved. Top soil shall be transported directly from the source to final position unless otherwise permitted. Top soil shall not be obtained from an area known to have noxious weeds growing in it.

211.02.03 Seed. Seed shall be of the varieties and proportions specified in the contract documents.

211.02.04 Fertilizer. Commercial fertilizer formulation and rate of application shall be as specified in the contract documents.

211.02.05 Mulch. (a) Hay or Straw. Hay or straw shall be seasoned before baling or loading and shall be acceptable to the Engineer. Rate of application shall be as specified in the contract documents. Hay or straw mulch material shall be chopped for blowing when specified in the contract documents.

(b) Wood Cellulose Fiber. Wood cellulose fiber shall be manufactured in such a manner that after addition and

agitation in slurry tanks with fertilizers, grass seeds, water, and other improved additives, the fibers in the material will become uniformly suspended to form a homogeneous slurry. When hydraulically sprayed on the ground, the material shall be uniformly impregnated with grass seed. Rate of application shall be as specified in the contract documents.

211.02.06 Asphalt Emulsion. Asphalt emulsion used as a tie-down for mulch shall be as described in the contract documents.

CONSTRUCTION

211.03.01 Preparation. Excavation slopes shall be thoroughly cultivated to the depth shown in the contract documents, after which topsoil, if required by the contract, shall be uniformly spread to an approximate thickness of two (2) inches, the exact thickness will be determined by the Engineer.

Cultivation of embankment slopes and covering with topsoil will not be required unless specified in the contract documents or ordered by the Engineer. If cultivation of embankment slopes and covering with topsoil is ordered by the Engineer, the cost of such work will be paid for as extra work as provided in subsection 104.03, "Extra Work."

Cultivation shall not be performed until all equipment is through working in the area, except equipment required to cultivate the area and spread topsoil.

211.03.02 Placement of Top Soil. Topsoil shall be evenly spread over the specified areas to the depth shown on the plans unless otherwise approved by the Engineer. After the topsoil has been spread, all large clods, hard lumps, rocks, and litter shall be raked up, removed, and disposed of by the Contractor.

Topsoil shall not be placed when the ground or topsoil is frozen, excessively wet, or, in the opinion of the Engineer, in a condition detrimental to the work.

All damage occurring to existing roadbeds, shoulders, walks, curbs, or other existing adjacent structures or areas

due to the Contractor's operation in hauling and placing the topsoil shall be repaired by the Contractor at his own cost and expense.

211.03.03 Compaction. All topsoil shall be compacted unless otherwise specified or approved by the Engineer. Compaction shall be by sheeps-foot roller, cleated crawler tractor, or similar equipment approved by the Engineer, which will produce a minimum of one hundred fifty (150) pounds per square inch ground pressure to a maximum of three hundred (300) pounds per square inch ground pressure. Equipment shall be so designed and constructed to produce a uniform rough textured surface ready for seeding and mulching, and which will bond the topsoil to the underlying material. The entire area shall be covered by a minimum of four (4) passes or two round trips of the roller or approved equipment. Compaction equipment shall be operated parallel to the natural flow of water on the slopes unless otherwise approved by the Engineer. Conveying the roller or approved equipment up and down the slopes shall be by means devised by the Contractor, providing that the required results are obtained to the satisfaction of the Engineer. After compaction, the finished grade of the topsoil shall be one (1) inch below the top of all curbs, catch basins and other structures.

If, in the opinion of the Engineer, water is required to condition the topsoil for compaction, it shall be immediately furnished and applied by the method and in the amount designated by the Engineer.

211.03.04 Seeding and Fertilizing. The Contractor shall notify the Engineer not less than twenty-four (24) hours in advance of any seeding operation and he shall not begin the work until areas prepared or designated for seeding have been approved. Following the Engineer's approval, seeding and fertilizing of the approved slopes shall begin immediately.

Seeding shall not be done during windy weather or when the ground is frozen. Seed and fertilizer shall be uniformly spread over the area at the rate and mix specified in the

contract documents. Seed and fertilizer may be sown by one of the following methods:

(a) An approved type hydro-seeder which utilizes water as the carrying agent and maintains a continuous agitator action that will keep seed and fertilizer mixed in uniform distribution until pumped from the tank. Pump pressure shall be such as to maintain a continuous, non-fluctuating stream of solution.

(b) Approved blower equipment with an adjustable disseminating device capable of maintaining a constant, measured rate of material discharge that will ensure an even distribution of seed and fertilizer at the rates herein specified.

(c) Helicopters properly equipped for aerial seeding and fertilizing. Helicopters so equipped shall have the following:

1. Two hoppers or seed compartments each capable of containing a minimum of one hundred (100) pounds of grass seed or granular fertilizer.

2. Power-driven, readily adjustable disseminating mechanisms capable of maintaining a constant, measured rate of distribution of grass seed or granular fertilizer.

3. Where liquid fertilizer is furnished in lieu of dry granular fertilizer, the helicopter shall be equipped with two barrels or containers capable of containing a minimum of fifteen (15) gallons each. Distribution shall be by a spray boom of sufficient size and length, fitted with proper nozzles to distribute uniformly, liquid fertilizer as herein specified.

(d) Approved power-drawn drills, seeders, or spreaders.

Areas inaccessible to above methods of application shall be seeded and fertilized by approved hand methods. Distribution of the material shall be uniform and at the rates specified.

It shall be the Contractor's responsibility to provide qualified personnel experienced in all phases of the seeding and fertilizing operation, equipment, and methods as herein specified.

211.03.05 Spreading Mulch. (a) Hay or Straw. Hay or straw mulch shall be furnished, hauled, and evenly applied at the rates indicated, and shall be spread on seeded areas within twenty-four (24) hours after seeding unless otherwise specified. Distribution of mulch material shall be by means of an approved type mulch spreader which utilizes forced air to blow mulch material on seeded areas, or by other approved methods. The spreader shall produce a uniform distribution of the hay, without cutting or breaking it into short stalks. Areas beyond the range of the mulch spreader shall be mulched by approved hand methods. Distribution of the material shall be uniform and at the rate specified in the contract documents.

(b) Wood Cellulose Fiber. Wood cellulose fiber utilized as a mulch may be applied with seed and fertilizer in one operation by approved hydraulic equipment. The equipment shall have a built in agitation system with an operating capacity sufficient to agitate, suspend and homogenously mix a slurry of the specified amount of fiber, fertilizer, seed, and water. Distribution and discharge lines shall be large enough to prevent stoppage and shall be equipped with a set of hydraulic discharge spray nozzles which will provide a uniform distribution of the slurry.

211.03.06 Applying Asphalt Emulsion. When called for in the contract documents, mulch material shall be anchored in place with asphalt emulsion as herein specified. Asphalt emulsion shall be sprayed into the mulch as it leaves the blower pipe and shall be uniformly mixed with the mulch. Asphalt emulsion as specified shall be applied at the rate of one hundred (100) gallons per acre. Any mulch disturbed or displaced following application shall be removed, reseeded, and remulched as specified.

211.03.07 Placing Jute Matting. Jute matting shall be unrolled and placed parallel to the flow of water immediately following the bringing to finished grade the area specified on the plans or the placing of seed and fertilizer. Where more than one strip is required to cover the given

areas, they shall overlap a minimum of four (4) inches. Ends shall overlap at least six (6) inches with the up-grade section on top. The up-slope end of each strip of matting shall be buried in six (6) inch slots with the soil firmly tamped against it. The Engineer may require that any other edge exposed to more than normal flow of water or strong prevailing winds be buried in a similar manner. Check slots shall be placed between the ends of strips by placing a tight fold of the matting at least six (6) inches vertically into the soil. These shall be tamped and stapled the same as up-slope ends. Check slots must be spaced so that one check slot or one end occurs within each fifty (50) feet of slope.

Edges of matting shall be buried around the edges of catch basins and other structures as herein described. Matting must be spread evenly and smoothly and in contact with the soil at all points.

Jute matting shall be held in place by approved wire staples, pins, spikes, or wooden stakes driven vertically into the soil. Matting shall be fastened at intervals not more than three (3) feet apart in three rows for each strip of matting, with one row along each edge and one row alternately spaced in the middle. All ends of the matting and check slots shall be fastened at six (6) inch intervals across their width. Fastening devices shall anchor the matting against the soil and be driven flush with the finished grade.

METHOD OF MEASUREMENT

211.04.01 Measurement. The quantity of topsoil measured for payment will be the number of cubic yards in the haul conveyance at the point of delivery and placed in the work. The quantity of seeding and fertilizing and mulching to be measured for payment will be the actual number of acres or square yards completed and measured along the ground slope. The quantity of jute matting to be measured for payment will be the number of square yards covered and measured along the ground slope.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

211.05.01 Payment. The accepted quantity of top soil measured as provided in subsection 211.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard of topsoil which price shall include hauling and placing.

The accepted quantities of seeding, fertilizing, mulching, and jute matting will be paid for at the contract unit price bid per acre or square yard as set forth in the proposal.

Water will be considered subsidiary to the major items of work and no further compensation will be allowed therefor.

Asphalt emulsion will be considered subsidiary to the item "Mulching" and no further compensation will be allowed therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Top Soil	Cubic Yard
Seeding (type)	Acre, Square Yard
Fertilizing (type)	Acre, Square Yard
Mulching (type)	Acre, Square Yard
Jute Matting	Square Yard
(type) Matting	Square Yard

SECTION 212

LANDSCAPING

DESCRIPTION

212.01.01 General. This work shall consist of furnishing and planting trees, shrubs, and ground covers where shown on the plans or established by the Engineer, all in accordance with specifications and accepted horticultural practices.

MATERIALS

212.02.01 General. The materials used shall be those prescribed for the several items which constitute the finished work and shall conform to the applicable requirements of Section 726, "Roadside Materials."

212.02.02 Nomenclature. Nomenclature for plant names and varieties shall be in accordance with the latest edition of "Standardized Plant Names" as prepared by the American Joint Committee on Horticultural Nomenclature.

All plant material will be classified by group as follows:

Plants, Group A.....Denotes canned plant material
Plants, Group B.....Denotes balled and burlapped plant material
Plants, Group C.....Denotes ground cover
Plants, Group D.....Denotes grass (turf)
Plants, Group E.....Denotes grass (meadow)

212.02.03 Quality of Plant Materials. It is the intent of these Standard Specifications that all plant material meet the standards as set forth herein, throughout the life of the contract. During inspections, as set forth hereinafter, all plant material will be judged and rejections shall be based upon these standards.

It is to be understood that when plant materials do not meet the standards and are rejected, that no consideration will be given to the possibility of survival.

Plants furnished by the Contractor shall have normal well-developed branch systems and be healthy, shapely

and well-rooted, and roots shall show no evidence of having been restricted or deformed at any time. Deformed or weak plants will not be accepted. Plants shall be well-grown, free from insect pests and disease, and shall be grown in nurseries which have been inspected by the State Department of Agriculture of the State from which they come, and have complied with the regulations thereof.

Root condition of plants furnished by the Contractor in containers will be determined by removal of earth from the roots of not less than two (2) plants nor more than two (2) percent of the total number of plants of each species or variety, except when container-grown plants are from several sources, the roots of not less than two (2) plants of each species or variety from each source will be inspected by the Engineer. In case the sample plants inspected are found to be defective, the Department reserves the right to reject the entire lot or lots of plants represented by the defective samples. Any plants rendered unsuitable for planting because of this inspection will be considered as samples and will not be paid for.

Any plants that, in the opinion of the Engineer, are thin, weak, dry, or in a wilted condition when delivered to the planting area, will not be approved for planting and shall be replaced by the Contractor at his expense. The fact that plants are not rejected prior to or during the planting operation does not constitute final approval and shall not be construed as final acceptane by the Engineer.

Grass seeds shall conform to the requirements of subsection 211.02.03, "Seed."

212.02.04 Handling and Shipping. Plants shall be packed for shipment according to standard practice for the type of plant being shipped. The root system of all plants shall not be permitted to dry out at any time. Plants shall be protected at all times against heat and freezing temperatures, sun, wind, climatic, or seasonal conditions during transit. All plant material shall be furnished in containers unless otherwise specified. All plants specified balled and burlapped (B & B) shall at all times be handled by the ball of earth and not the plant. Broken or "made" balls will not

be accepted. Container grown plants shall be well developed with sufficient root development to hold the earth intact after removal from the container without being root bound.

212.02.05 Inspection of Plant Material. The Contractor shall, as soon as practical, inform the Engineer as to the source of plant materials for the project. All plants intended for use by the Contractor are subject to inspection at any time by the Engineer. Approval of plant material for a project shall not be considered as final acceptance. The Contractor shall notify the Engineer not less than seven (7) days in advance of delivery of plants from the nursery.

All plants will be inspected by the Engineer on arrival at the project and before the time of planting. Root condition of plants furnished in containers shall be determined by removal of the plant from the container. Plants not meeting the requirements herein specified shall be immediately removed from the project and replaced by the Contractor at his expense.

212.02.06 Substitution of Plants. No substitution of plant material will be permitted unless evidence is submitted in writing to the Engineer that a specified plant cannot be obtained and has been unobtainable since the award of the contract. If substitution is permitted, it can be made only with written approval by the Engineer. The nearest variety, size, and grade as approved by the Engineer shall then be furnished.

212.02.07 Temporary Storage. Plant material delivered and accepted shall be planted immediately. Plants that cannot be planted within one (1) day after arrival shall be "heeled-in" in accordance with accepted horticultural practice, and as follows:

(a) Balled and burlapped plants shall have the root ball protected by moist earth, sawdust, or other acceptable material.

(b) Canned plants shall be placed in and under shelter and kept moist.

Plants stored under temporary conditions shall be protected at all times from extreme weather conditions, and shall be kept moist.

212.02.08 Top Soil. Top soil shall conform to the applicable requirements of Section 726, "Roadside Material."

212.02.09 Lumber. Lumber for header boards and plant boxes shall conform to the requirements of Section 718, "Timber."

CONSTRUCTION

212.03.01 Site Preparation. This work shall consist of all work necessary, as set forth in the contract documents, such as roadway construction, drainage facilities, grading, cleaning, etc., to prepare the area for the actual landscaping work. All work as set forth herein shall be completed and approved by the Engineer prior to beginning any preparation of the planting areas.

212.03.02 Layout of Planting. The Contractor will designate, by means of stakes or other approved markings, the ground location of each random placed plant. Areas of massed or uniform solid plantings shall be marked at their outer extremes only. The Engineer's approval of plant stakeout will be required prior to the commencement of the preparation of planting areas.

In mixed planting areas, trees shall be planted first, followed by the larger shrubs, low shrubs, and the final planting of ground covers.

212.03.03 Preparation of Planting Areas. During the preparation of planting areas, all clods, rocks, or other debris over one (1) inch in largest dimension shall be removed from both cultivated areas and backfill material, and disposed of as directed by the Engineer. In addition thereto, the following requirements will apply:

(a) Planter Boxes. Backfill material shall consist of one part humus to three parts top soil by volume. This material

shall be thoroughly and uniformly mixed before placing in the planter boxes. After placing in the planter box, the material shall be watered until it is completely saturated. Sufficient backfill mixture shall be added and adequately wet so that after settlement has taken place, the material is approximately two (2) inches below the top of the box.

(b) Planting Beds. The soil preparation shall not be initiated until after all grading has been completed and the irrigation system has been installed, tested, adjusted, and accepted by the Engineer. The ground surface within the area shall then be loosened and thoroughly pulverized to a depth of six (6) inches. When required, humus, commercial fertilizer, and other additives shall be incorporated at the rate specified in the contract documents, and shall be thoroughly and uniformly tilled into the soil to a depth of six (6) inches. The area shall then be brought to a plane in conformance to the elevations shown on the plans. The area to be planted shall then be consolidated with approved cultipackers or rollers.

(c) Seed Beds. The soil preparation shall be the same as specified for planting beds.

(d) Planting Holes. Prior to drilling holes, the proposed location of the irrigation lines shall be designated by means of stakes or other approved markings. In the event of conflict between individual planting holes and irrigation lines, the planting holes in question shall be drilled prior to installing the irrigation lines.

All holes shall be drilled with a power auger to the dimensions specified in the contract documents unless otherwise approved by the Engineer. Holes shall be drilled at the location of each individual plant, the stake or marking being considered the center of the hole. The holes shall have vertical walls and horizontal bottoms.

When required, humus, commercial fertilizer, and other additives shall be incorporated at the rates specified in the contract documents and shall be thoroughly and uniformly mixed with the material removed from the holes prior to backfilling. After backfilling the holes, the material shall be saturated with water to the full depth of the hole and until ponding appears in the basin. Sufficient backfill material

shall be placed so that after planting and settlement has taken place, the basin will conform to the section as shown in the plans.

(e) Planting Trenches. Trenches shall be excavated to the dimensions specified in the contract documents and shall be centered on the planting line as staked or otherwise marked.

When required, humus, commercial fertilizer, and other additives shall be incorporated at the rates specified in the contract documents and shall be thoroughly and uniformly mixed with the material removed from the trenches prior to backfilling. After backfilling the trenches, the material shall be saturated with water to the full depth of the trench. Cross checks may be formed as necessary to permit ponding of water during the saturation period but must be removed prior to planting. Sufficient backfill material shall be placed so that after planting and settlement has taken place, the basin will conform to the section as shown in the plans.

212.03.04 Planting. No planting shall be done in any area until the Contractor has received from the Engineer a written statement that the area concerned has been satisfactorily prepared as provided in subsection 212.03.-03, "Preparation of Planting Areas."

No more plants shall be distributed within the project area on any one day than can be planted and watered on that day.

Any planting done in soil that is too wet or too dry or not properly conditioned as provided herein will not be accepted. No payment will be made for such planting and any further planting work will be suspended until the Contractor has complied in every way with the specifications.

(a) Plants (Group A). Nursery stakes supporting shrubs in containers shall be removed and the plants properly pruned as specified herein.

Containers shall be cut, at least twice, from top to bottom and plants shall be removed from the containers in such a manner that the ball of earth surrounding the roots is not broken and they shall be planted and watered

as hereinafter specified immediately after removal from the containers. Containers shall not be cut prior to delivery of the plants to the planting areas.

(b) Plants (Group B). Balled and burlapped material shall have all strings or cords cut, and the burlap shall be laid back from the top half of the ball. This shall be done only after the plant is placed in its final position and before completion of the backfill.

(c) Plants (Group C). As soon as each plant is removed from its container, it shall be planted in the prepared planting bed, in a hole previously prepared with a broad, blunt end trowel. The plant shall be carefully lifted with the trowel, inserted in the hole, and the earth shall be gently firmed around it to eliminate air pockets.

Plants brought to the jobsite in plastic or clay pots shall be tapped loose from their containers in such a manner that the ball of earth surrounding the roots is not broken, and then immediately planted. Plants which are brought to the jobsite in peat pots may be planted in the pots, provided the peat fiber is thoroughly wet. Plants which are brought to the jobsite in other cellulose fiber pots shall have the pots carefully removed by tapping or peeling before planting. No plants brought to the jobsite in flats, pony pacs, or bare root will be accepted.

Plants shall be watered as hereinafter specified immediately after planting.

Roots of plants not in containers shall be kept moist and covered at all times and shall not be exposed to the air except while actually being placed in the ground.

Plants shall be set in a plumb position in the backfill mixture material to such a depth that, after the soil has settled, the top of the plant ball will be level with the finished grade.

Plants shall be planted in such a manner that the roots will not be restricted or distorted. Soil shall not be compacted around the roots or ball of the plant during or after planting operations. Any plants which have settled deeper than specified in the above paragraph shall be raised back to the required level, or replaced, at the option of the Contractor.

(d) Plants (Group D). The seed bed shall be in a moist friable condition when seeding is begun. Seeding shall be done as soon as soil conditions allow after the initial watering of the amended soil. Seeding done in soil that is too wet or too dry, or in a condition not generally accepted as satisfactory for lawn seeding will not be accepted. No payment will be made for seeding when the soil condition is considered unsatisfactory and any further seeding work will be suspended until the Contractor has complied in every way with these provisions.

Seed shall be sown from standard mechanical grass seeding equipment with adjustable gate, as appropriate to the area, and at the rate shown on the plans. After sowing, the seed shall be covered by light raking or dragging and seeded areas compacted by rolling. The Contractor shall exercise care to avoid leaving any footprints or other depressions in the compacted seed bed.

Humus mulch shall be evenly applied immediately after the seed bed has been compacted, with manure spreaders, mulch blowers or other approved equipment. Humus shall be spread at the rate of one (1) cubic yard per thousand (1,000) square feet. As soon as mulch is in place, the surface of the seed bed is to be dampened with a fine spray from a nozzle until the mulch is thoroughly moist.

(e) Plants (Group E). The seed bed shall be in a moist, friable condition when seeding is begun. Seeding shall be done as soon as soil conditions allow after the initial watering of the amended soil. Seeding done in soil that is too wet or too dry, or in a condition not generally accepted as satisfactory for lawn seeding will not be accepted. No payment will be made for seeding when soil condition is considered unsatisfactory and any further seeding work will be suspended until the Contractor has complied in every way with these provisions.

Seed shall be sown from standard mechanical grass seeding equipment with adjustable gate, as appropriate to the area, and at the rate shown on the plans. After sowing, the seed shall be covered by rolling. The Contractor shall exercise care to avoid leaving any footprints or other depressions in the compacted seed bed.

212.03.05 Staking and Guying. All staking and guying shall be done concurrently with the planting operation.

(a) Staking. Plants which are to be staked will be specified in the contract documents.

The size, number of stakes, and the depth to be driven shall be as specified in the contract documents, or as approved by the Engineer.

The stakes shall be placed against but not through the plant ball in the case of Plants (Groups A and B).

(b) Tree Ties. The method of attaching the ties to stakes and trees shall provide firm connection, as shown in the plans, or as approved by the Engineer. It may, on occasion, as determined by the Engineer, be considered necessary to use number 10 gage galvanized wire encased in at least one-half (½) inch black rubber hose as tree ties, in which case all connections shall be twisted.

(c) Guying. Plants which are to be guyed will be specified in the contract documents.

All guying shall be done as specified in the contract documents or as approved by the Engineer.

212.03.06 Pruning. Pruning shall be done as determined by the Engineer before plant materials are brought to the jobsite and planting areas.

Pruning of evergreen coniferous plants will not be permitted except under the direction of the Engineer.

Removal of dead leaves from ground cover plants shall be done before these plants are brought to the planting areas.

212.03.07 Watering. If water is available from a new or existing State-owned irrigation system within the limits of the project, it may be obtained from such system free of charge. Where water is not available from such State-owned facility, the Contractor shall make his own arrangements for furnishing and applying water and he shall pay all costs involved.

Valves at meters shall be kept closed at all times, except while the irrigation system is actually in use.

Precautions shall be taken during times when the irrigation system is on to prevent water from wetting vehicles, pedestrians, and pavement. Any erosion, slippage, or settlement of the soil caused by watering shall be repaired by the Contractor at his expense.

Compliance with the provisions in this section shall not relieve the Contractor of his responsibility for his replacement of plants as provided hereinafter.

(a) Plants (Groups A and B). All plants shall be watered immediately after planting. Water shall be applied in a moderate stream until the backfill soil around and below the roots or ball, or earth around each plant, is thoroughly saturated. Where watering is done with a hose, a metal or plastic pressure reducing device approved by the Engineer shall be used. Under no circumstances shall the full force of the water from the open end of a hose be allowed to fall within the basin around any plant.

After the first watering, water shall be applied to all plants as often and in sufficient amount as conditions may require to keep the soil wet above, around, and below the root systems of the plants during the life of the contract. After the installed irrigation system has been accepted, it may be used to water the planted area.

Any additional watering measures required to initially saturate the backfill, water the plants immediately after planting, or to maintain the plants in a satisfactory growing condition shall be anticipated and furnished by the Contractor at his expense.

(b) Plants (Group C). As soon as all the perennials in a given area have been planted, water shall be applied to that area in a fine mist from an atomizing nozzle until the entire planting bed is saturated. This initial watering shall not be done with the installed irrigation system.

After the first watering, water shall be applied to the areas as often and in sufficient amount as conditions may require to keep the soil wet above, around, and below the root systems of the plants during the life of the contract.

(c) Plants (Groups D and E). The seed beds shall be

kept in a moist but not soggy condition until after germination. After germination, water shall be applied to the areas as often and in sufficient amount as conditions may require during the life of the contract.

The installed turf irrigation system may be used to water those areas as long as care is taken to prevent erosion or other damage to the area. However, should the irrigation system prove to be unsatisfactory, other means of watering, as approved by the Engineer, shall be used until germination is complete and all grass has attained a height of one (1) inch. After a uniform stand of grass which has attained a height of one (1) inch has been achieved over the entire turf area, the installed turf irrigation system may be used to keep the area moist.

212.03.08 Replacements. (a) Plants (Groups A, B, and C). During the planting and plant establishment period of the project, all plants that show signs of failure to grow normally or which are so injured or damaged as to render them unsuitable for the purpose intended, as determined by the Engineer, shall be removed and replaced in kind. The Engineer will inspect the work on the first or second working day of each week during the planting and plant establishment periods, and will mark or otherwise indicate all plants to be replaced. The Contractor shall complete replacement of such plants as soon as possible, but in no case shall the Contractor take more than two (2) weeks to complete the replacement.

Plants required to replace plants shall be furnished and planted by the Contractor at his expense.

(b) Plants (Groups D and E). The Engineer will inspect the turf at the time of the second cutting and the meadow area when the grass has reached a height of approximately two (2) inches and will designate any areas which need reseeding. Seed used for reseeding shall be the same types and amounts as specified for the initial planting and shall be planted in accordance with the contract documents or as directed by the Engineer. The cost of the seed and actual reseeding shall be borne by the Contractor.

212.03.09 Fertilizers and Additives. When fertilizers or additives are called for, they shall be applied at the rates and as specified in the contract documents or as approved by the Engineer.

212.03.10 Protection of Existing Facilities. Any existing buildings, equipment, piping, pipe covering, sprinkling systems, sewers, sidewalks, landscaping, utilities, roadways, or any other improvement of facilities damaged due to the Contractor's operations shall be repaired or replaced by the Contractor at his expense as directed by the Engineer.

212.03.11 Plant Establishment Work. This work shall consist of watering and caring for all of the plants and planting areas, the replacement of plants, the weeding and general maintenance as specified in the contract documents.

The plant establishment period shall begin at such time as all planting has been accomplished and all other work has been completed and the project is in a neat and clean condition.

The length of the plant establishment period shall be as specified in the contract documents.

The Engineer will notify the Contractor in writing of the start of the plant establishment period and will furnish statements regarding days credited to the plant establishment period after said notification.

The time required for plant establishment work shall be considered as included in the total time limit specified for the contract. Any day upon which no work is required, as determined by the Engineer, will be credited as one of the plant establishment days regardless of whether or not the Contractor performs plant establishment work.

Any day when the Contractor fails to adequately water plants, replace unsuitable or damaged plants, do weed control, adjust or replace bracing and ties, or other work, as determined necessary by the Engineer, will not be credited as one of the plant establishment days. No extension

of contract time will be granted beyond the final completion date by reason of failing to perform plant establishment work on days when such work is necessary.

All plants shall be kept watered as provided in "Watering" in these standard specifications.

Surplus earth, papers, trash, and debris, which accumulate in the planted areas shall be removed and disposed of in accordance with the provisions in subsection 107.14, "Disposal of Material Outside the Highway Right of Way," and the planted areas shall be so cared for as to present a neat and clean condition at all times.

During the plant establishment period, trees and shrubs shall be pruned or headed back by the Contractor at his expense, when and as directed by the Engineer.

In order to carry out the plant establishment work the Contractor shall furnish sufficient men and adequate equipment to perform the work during the plant establishment period.

METHOD OF MEASUREMENT

212.04.01 Measurement. The quantity of materials and work measured for payment will be materials and work complete and in place. The various items will be measured in the manner and by the unit as follows:

(a) Site preparation will be measured by the acre.

(b) Topsoil will be measured by the cubic yard in the hauling vehicle at the jobsite.

(c) Preparing soil (plant boxes) will be measured by the square foot.

(d) Preparing soil (plant bed) will be measured by the square foot.

(e) Fertilizer will be measured by the pound determined by marked quantities and sack count, by the ton, by each stick or pellet, or by the gallon, all as designated in the proposal.

(f) Humus will be measured by the cubic yard in the hauling vehicle at the jobsite or by the cubic yard determined by marked quantities and sack count.

(g) Mulch will be measured by the cubic yard in the

hauling vehicle at the jobsite or by the cubic yard determined by marked quantities and sack count.

(h) Hole preparation will be measured by the actual number of holes prepared.

(i) Trench preparation will be measured by the linear foot and the depth and width of the trench will be designated in the contract documents.

(j) Tree rings will be measured by the number of rings used in the work. Each size will be considered separately and so designated in the proposal.

(k) Mowing strips will be measured by the number of linear feet along the top of the strip.

(l) Planter boxes will be measured by the number of boxes placed on the project that conform to the sizes specified in the contract documents.

(m) Header boards will be measured by the thousand foot board measure (Mfbm).

(n) Plants in Groups A through C will be measured by the number of plants in each group.

(o) Plants in Groups D and E inclusively will be measured by the square foot in place, with each group considered separately.

(p) The unit of measure for Plant Establishment Work will be lump sum.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

212.05.01 Payment. The accepted quantities for items of this section measured as provided in subsection 212.04.01, "Measurement," will be paid for at the contract unit price bid for the type, size, group, or whatever information is necessary for identification, and so identified in the proposal. Such payment shall be full compensation for all the labor, materials, and incidentals necessary to complete the work.

Water will be considered subsidiary to the major items of work and no further compensation will be allowed therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Site Preparation	Acre
Top Soil	Cubic Yard
Preparing Soil (plant boxes)	Square Foot
Preparing Soil (planting bed)	Square Foot
Fertilizer (type and class)	Pounds, Ton, Each, Gallons
Humus (type)	Cubic Yard
Mulch (type)	Cubic Yard
Hole Preparation	Each
Trench Preparation	Linear Foot
Mowing Strips	Linear Foot
Planter Boxes (type, size)	Each
Header Boards (type lumber, size)	Mfbm
Plants (Groups A–C)	Each
Plants (Groups D–E)	Square Foot
Plant Establishment Work	Lump Sum

SECTION 213

IRRIGATION SYSTEMS

DESCRIPTION

213.01.01 General. This work shall consist of furnishing all materials and labor required to install an irrigation system in accordance with these specifications and the details shown on the plans.

MATERIALS

213.02.01 General. All materials and equipment incorporated in the sprinkler system shall be new, undamaged, of standard quality and shall be subject to testing as specified herein. The materials used shall be those prescribed for the several items which constitute the finished work and shall conform to the applicable requirements of Section 726, "Roadside Materials."

213.02.02 Pipe and Fittings. Pipe and pipe fittings shall conform to the requirements of subsection 726.03.09, "Pipe and Fittings."

213.02.03 Control Tubing. Tubing and fittings shall be capable of withstanding a three hundred (300) psi operating pressure, and shall be of the size indicated on the plans.

213.02.04 Automatic Controllers. When called for on the plans, the Contractor shall furnish and install on a concrete base, automatic controllers as herein specified. They shall be an electrically timed device for automatically opening and closing control valves for predetermined periods of time and mounted so that all normal adjustments will be conveniently located for use by the operator. Controllers shall be enclosed in a weatherproof metal housing with hasp and lock or locking device. All locks or locking devices shall be master keyed and three (3) sets of keys provided. Operating features shall include the following:

(a) Each valve in the circuit shall be adjustable for setting to remain open for any desired period of time—from five (5) minutes or less to at least one (1) hour.

(b) Controller adjustments shall be such that the open cycle may be halved, doubled or repeated not less than three times during the complete watering cycle.

(c) Adjustments shall be provided whereby any number of days may be omitted and whereby any one or more positions on the controller can be skipped. When adjustments are made they shall continue automatically within a fourteen (14) day cycle until the operator desires to make new adjustments.

(d) Controls shall allow any position to be operated manually both on or off whenever desired.

(e) Controls shall provide for resetting the start of the irrigation cycle at any time and advancing from one position to another.

(f) Controllers shall contain an "on-off" switch and fuse assembly.

(g) Sprinkler connections shall be quick coupling valves with double slot, three-fourths (¾) inch pipe opening and self-closing cap. Except for the cap, quick coupling valves shall be of all brass or bronze construction.

213.02.05 Sprinkler Heads. Sprinkler heads shall be of the type, pattern and coverage shown on the plans. All heads shall be constructed of heavy duty bronze, brass, or stainless steel. When rotary type heads are specified on the plans they shall be turbine driven with hardened bronze cams with the speed of rotation adjustable. Sprinklers shall be interchangeable nozzles. Watering cores shall be precision machines for accurate performance and shall be easily removed without removing the housing from the pipe. All turf heads shall be designed with turf flanges having two gripping holes or slots to facilitate removal of the head.

213.02.06 Valve Protection Sleeves. All valves shall be equipped with a protective sleeve and cap as shown on the plans. Protective sleeves shall be plain concrete pipe of the size and length called for on the plans.

213.02.07 Gate Valves. Valves shall be of the same size as the pipes on which they are placed and shall have union or flange connections. Service rating (for nonshock cold water) shall be three hundred (300) psi. Valves shall be of the double disk, taper seat type, with rising stem, union bonnet, and hand-wheel. Manufacturer's name, type of valve, and size shall be cast on the valve.

213.02.08 Control Valves. Manual section control valves shall be bronze angle valves, renewable disk type with rising stem and either screwed or union bonnet, fitted for key operation. Service rating shall not be less than one hundred fifty (150) psi nonshock cold water.

Automatic remote control valves shall be brass or bronze, pattern as specified with flanged or screwed outlet. Screwed valves shall be provided with union connections or a short brass nipple with brass union. Valves shall be of a "normally closed" design and shall be opened and closed by water pressure in the control tubing as required by the automatic controller. Valves shall be designed to have a manual adjustment from fully closed to wide open. Once the manual adjustment is set, the valve shall operate automatically in the adjusted position. Water flow shall be completely stopped when the control valve is closed either manually or automatically. Automatic remote control valves and automatic controllers shall be of the same manufacture.

213.02.09 Quick Coupler Valves. Base of the valve shall have standard female pipe threads. Design of the valve shall be such that it will open only upon inserting a coupler device, and will close as the coupler is removed from the valve. Leakage of water between the coupler and valve body when in operation will not be accepted. The valve body receiving the coupler shall be designed with double worm slots to allow smooth action in opening and closing of the valve with a minimum of effort. Slots shall be notched at the base to hold the coupler firmly in the open position. Couplers shall be of the same material as the valve body with stainless steel double guide lugs to fit

the worm slots. Couplers shall be of one piece construction with steel reinforced side handles attached. All couplers shall have standard male pipe threads at the top. Couplers shall be furnished with all quick coupler valves unless otherwise specified.

213.02.10 Valve Boxes. Valve boxes shall be precast Portland cement concrete boxes of the dimensions shown on the plans with a one piece concrete cover.

213.02.11 Backflow Preventers. Backflow preventers shall meet the requirements of the governing agency concerned. Each backflow preventer shall be equipped with a gate valve at each end of the backflow prevention unit. Three (3) inch and larger valves shall be flanged type, iron body, brass trimmed, wedge gate valves with non-rising stem, and shall be capable of withstanding a cold water working pressure of two hundred (200) pounds per square inch. Two and one-half (2½) inch and smaller valves shall be as specified above, except they shall be screwed type and shall be installed with a union between each valve and the backflow prevention unit. Backflow preventers and valves shall be the size shown on the plans.

It will be the responsibility of the Contractor to determine the requirements of the governing agency in regard to the type and detail of backflow prevention required.

For purpose of payment the valves required to be installed at each end of the backflow prevention unit and all fittings between such valves required for proper installation shall be considered as a part of the backflow preventer.

213.02.12 Drain Valves. Drain valves shall be bronze or brass stop cocks with a service rating of one hundred twenty-five (125) psi. Design shall be flathead with checks. The Contractor shall furnish a suitable operating key. Each drain valve shall be placed in a drain pit which shall be constructed in accordance with the detail on the plans.

213.02.13 Hose Bibs. Hose bibs shall be constructed of bronze or brass, angle type threaded to accommodate a

three-fourths (¾) inch hose connection and shall be key operated. Design shall be such as to prevent operation by wrench or pliers.

213.02.14 Vacuum Breakers. When called for in the contract documents or as required by local ordinances, vacuum breakers meeting the following requirements shall be furnished and installed. All vacuum breaker installations are subject to inspection by authorized county or municipal authorities.

Atmospheric vacuum breakers shall have all bronze bodies and be of the same dimension as the pipe on which it is attached. Design shall permit free flow of water under pressure. When vacuum conditions exist it shall automatically close the check valve stopping all flow of water and admit air into the main line. Upon restoration of water pressure the air intake shall be shut off and the check valve re-opened without spillage. Unless otherwise specified, the vacuum breaker shall be installed on the discharge side of the control valve six (6) inches above the highest sprinkler head on the line. Vacuum breakers shall not be required on sprinkler lines when all sprinkler heads on the line are elevated to a minimum of six (6) inches above the finished grade, such as sprinkler lines irrigating shrub beds. Atmospheric vacuum breakers shall have a service rating of one hundred fifty (150) psi for non-shock cold water and shall be designed for operation up to temperatures one hundred forty (140) degrees Fahrenheit.

Pressure type vacuum breakers shall be installed on the discharge side of the meter or service connection as shown on the plans. Vacuum breakers shall be of heavy duty construction with all bronze bodies, check valves, and test cocks. Pressure type vacuum breakers shall be designed to operate under continuous pressure permitting the free flow of water at all times. Air intake shall be spring loaded to insure positive opening upon release of pressure or vacuum created in the supply lines. Vacuum breakers shall be furnished with approved check valves, inlet and discharge shut-off valves and field testing cocks. Assembly for various pipe sizes shall be according to local requirements or

as specified in the contract documents. Unless otherwise specified pressure type vacuum breakers shall have a service rating of three hundred (300) psi for non-shock cold water.

All vacuum breaker installations shall meet local ordinances and plumbing requirements.

CONSTRUCTION

213.03.01 General. The Contractor shall not alter or change the location of pipes, valves, sprinklers, or other equipment as shown on the plans unless so authorized by the Engineer. All necessary arrangements for connecting to mains shall be made by the Contractor with the agency supplying the water, and such installations and equipment shall conform to the requirements set forth by the supplying agency.

213.03.02 Excavation. Pipe trenches shall be no wider at any point than is necessary to lay the pipe or install equipment. The top six (6) inches of top soil, when such exists, shall be kept separate from subsoil and shall be replaced as the top layer when backfill is made. Trenches shall be excavated with vertical sides and provided with bracing and shoring to be placed as designated by the Engineer. Trenches in rock or like material shall be excavated six (6) inches below the required depth and shall be backfilled to required depth with sand or other suitable material free from rock or stones.

213.03.03 Excavation Adjacent to Trees. Care shall be exercised by the Contractor when excavating trenches near existing trees. Where roots are two (2) inches and greater in diameter, except in the direct path of the pipe, the pipe trench shall be hand excavated and tunneled. When large roots are exposed they shall be wrapped with heavy burlap for protection and to prevent excessive drying. Trenches dug by machines adjacent to trees having roots two (2) inches and less in diameter shall have the sides hand trimmed making a clean cut of the roots. All roots one-half (½) inch or greater in diameter that are

cut and trimmed shall be treated with an approved tree wound dressing. Trenches having exposed tree roots shall be backfilled within twenty-four (24) hours unless adequately protected by moist burlap or canvas.

213.03.04 Piping. All live main lines shall be a minimum of twenty-four (24) inches below finished grade measured from the top of the pipe. Lateral or section lines shall be a minimum of twelve (12) inches below finished grade measured from the top of the pipe. Pipes shall be sloped to drain without sags. Unless otherwise specified, drain valves shall be placed only at the low point of all lateral or section lines. All live mains located under existing pavement shall be placed in conduits jacked under pavement unless otherwise noted on the plans or approved by the Engineer. Conduits shall be no larger than necessary to conveniently accommodate the pipe and fittings. Where necessary, live mains ad control tubing may be placed in separate conduits laid adjacent and parallel. All jacking operations shall be performed in a manner approved by the Engineer and conduit run at a depth below the pavement as may be ordered. Where possible, mains and laterals or section piping shall be placed in the same trench.

213.03.05 Jointing. All galvanized steel pipe shall have sound, clean cut standard pipe threads well fitted. All pipe shall be well reamed to the full diameter and burrs removed before assembly. Threaded joints shall be made up with the best quality pure lead paste, applied smoothly and evenly to the male thread only. All screwed joints shall be made tight with tongs and wrenches without the use of handle extensions. Any joints that leak shall be cleaned and remade with new material. Caulking or thread cement to make joints tight will not be permitted.

213.03.06 Control Tubing. Copper control tubing shall be joined with brass or bronze screwed compression type fittings. Ends of tubing to be joined shall be uniformly cut, burred, and flanged. Directional changes requiring less than a three (3) inch radius shall be made with ninety (90) degree ell fittings.

213.03.07 Installation. Conduit shall be installed not less than one and one-half (1½) feet below the curb grade in sidewalk areas and not less than three and one-half (3½) feet below the finished grade in all other areas. Conduit shall be installed under existing pavement by approved jacking or drilling methods. Pavement shall not be disturbed without the approval of the Engineer, and then only in the event obstructions are encountered. When permitted by the Engineer, small test holes may be cut in the pavement to locate obstructions. Jacking or drilling pits shall be kept at least two (2) feet from pavement edge wherever possible. Excessive use of water that will soften subgrade or undermine the pavement will not be permitted.

Where conduit is installed in an open trench, excavation and backfill shall conform to the provisions in Sections 206, "Structure Excavation" and 207, "Backfill." The conduit shall be laid in the trench to the lines and grades established by the Engineer. The bottom of the trench shall be graded and prepared to provide a firm and uniform bearing throughout the entire length of the conduit. During backfilling operations, the conduit shall be rigidly supported so that no movement of or damage to the conduit or joints will result.

After the conduit is installed, if shown on the plans or specified in the special provisions, galvanized steel pipe shall be placed therein.

Bushings may be used only when it is necessary to reduce the pipe size between a supply line and a riser supplying water to a single terminal fitting such as a sprinkler, sprinkler connection, or garden valve. Unless otherwise provided, reducers shall be used whenever it is necessary to increase or reduce the size of galvanized steel supply lines.

Where connection is made to existing supply lines, compression type fittings may be used.

A backflow preventer shall be installed at each meter if called for on the plans.

Galvanized steel pipe supply lines shall be placed at

sufficient depth to provide eight (8) inches of cover over the top of pipe, or as otherwise shown on the plans.

Where supply lines or conduits are to be installed through existing paved areas, the subbase, base, and paving removed shall be replaced with material of equal quality.

All pipe shall be cut straight and true. After cutting, the ends shall be reamed out to the full inside diameter of the pipe.

Male pipe threads shall be coated with a joint compound containing a minimum of seventy (70) percent of 200-mesh lead in a hydrocarbon vehicle.

Where sprinkler connections will be subject to damage by traffic, concrete valve protectors shall be placed at locations directed by the Engineer.

Foreign material shall be prevented from entering the irrigation system during installation. Immediately prior to assembling, all pipes, valves, and fittings shall be cleaned. All unattached ends of pipe, fittings, and valves shall be plugged or capped pending attachment of additional pipe or fittings. All lines shall be thoroughly flushed out prior to attachment of terminal fittings.

Before any portion of the pipeline is backfilled, water shall be turned into that portion of the line and maintained at full pressure for a period of not less than eight (8) consecutive hours after all air has been expelled from the line. Any leaks that develop in the portion of the system installed by the Contractor shall be repaired and all defective materials shall be replaced by him. The pipe shall be plugged or capped where sprinklers are to be installed while making this test. The entire system shall then be checked for uniform and complete coverage after installing sprinklers.

Where water lines and garden valves are to be installed in median areas, garden valves shall be placed at the low side of drop inlets and the high point of vertical curves.

The average spacing of garden valves, sprinklers, and sprinkler connections shall be based on a module of

twenty-one (21) feet (42′, 63′, 84′, etc.), unless otherwise noted on the plans.

Garden valves and sprinkler connections shall be installed three (3) feet from curbs, dikes, sidewalks, and paved shoulders unless otherwise shown on the plans.

Nozzle lines shown on the plans immediately adjacent to a fence or guard railing shall be installed on the fence or guard railing, and those immediately adjacent to a curb or shoulder shall be installed three (3) feet from the curb or paved shoulder unless otherwise noted on the plans.

All nozzle lines, except those installed on a fence or guard railing, shall be installed on three-fourths (¾) inch pipe anchor posts unless otherwise shown on the plans.

Sprinkler connections shall be installed on swing joints as detailed on the plans.

213.03.08 Control Tubing Installation. Control tubing shall be placed with the main supply line. Tubing shall be bundled together by four wraps of friction tape at six (6) foot intervals. Location of the bundle of control tubing shall be to one side of the pipe, and a minimum of two (2) inches from any galvanized pipe.

213.03.09 Flushing and Testing. All main supply lines shall be flushed completely of foreign particles before placing section control valves, quick-coupler valves and hose bibs. After flushing and when valves are in place, all main supply lines shall be tested at one hundred fifty (150) psi with valves closed. Pressure shall be maintained for a period of eight (8) consecutive hours. All joints showing leaks shall be cleaned, remade, and tested.

After installation of section lines, the piping shall be completely flushed of foreign particles before attaching sprinkler heads and drain valves. After flushing, section lines shall be tested with risers capped and drain valves closed. The test shall be made at maximum operating pressure for a period of one (1) hour. Any pipe, fittings or joints showing leaks will not be accepted. All joints showing leaks shall be cleaned, remade and tested. Control tubing shall be tested in the manner specified hereinbefore

for the main supply lines. Tubing shall be flushed for five (5) minutes before connection with the control valves.

Automatic controllers shall be tested by actual operation for a period of two (2) weeks under normal operating conditions. Should adjustments be required, the Contractor shall do so according to manufacturer's direction and test until operation is satisfactory.

213.03.10 Adjusting System. Before final inspection the Contractor shall adjust and balance all sprinklers to provide adequate and uniform coverage. Spray patterns shall be balanced by adjusting individual sprinkler heads with the adjustment screws or replacing nozzles to produce a uniform pattern. Unless otherwise specified, sprinkler spray patterns will not be permitted on pavement, walks, or structures.

213.03.11 Backfill. Backfill shall not be started until all piping has been inspected, tested, and approved by the Engineer, after which, backfilling shall be completed as soon as possible. Upon completion of all piping in the same trench, backfill shall be completed as specified. Trenches containing control tubing shall have a three (3) inch sand or sandy loam cushion free from rocks or stones larger than three-eighths (⅜) inch in diameter placed over all control tubing. Backfill from the bottom of the trench to approximately six (6) inches above the pipe shall be by continuous tamping in such a manner that will not damage pipe or control tubing and shall proceed evenly on both sides of the pipe. The remainder of the backfill shall be thoroughly tamped, except that heavy equipment shall not be used within eighteen (18) inches of any pipe. All backfill material shall be free of rocks, roots, or other objectional material. The top six (6) inches of the backfill shall be of top soil material or the first six (6) inches of material removed in the excavation.

METHOD OF MEASUREMENT

213.04.01 Measurement. The materials to be measured for payment under these specifications will be listed

in the contract items by size, class, type, gage, or whatever information is necessary for identification.

The quantity of pipe and tubing to be measured for payment will be the actual number of linear feet of the type specified complete and in place. Pipe bends, wyes, tees, and other branches will be measured along center lines to the point of intersection.

The quantity of sprinklers, couplers, heads, valves, vacuum breakers, hose bibs, concrete valve boxes, valve assemblies, riser assemblies, and faucets will be measured per each of the type and size specified complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

213.05.01 Payment. The accepted quantities of pipe and tubing measured as specified in subsection 213.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for the types and sizes specified.

The accepted quantity of all other attachments measured as specified in subsection 213.04.01, "Measurement," will be paid for at the contract unit price bid per each for the types and sizes specified.

The above payment will be full compensation for furnishing all the material and labor necessary to install the system. Such payment shall include excavation, backfill, restoring sidewalk, curb, gutter, pavement, and appurtenances damaged or destroyed by construction and making all required tests.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) (type) Pipe	Linear Foot
(size) (type) (name of attachment)	Each

SECTION 301

SELECTED MATERIAL BASE OR SURFACE

DESCRIPTION

301.01.01 General. This work shall consist of excavating and placing selected granular materials in one or more courses for base or surface in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer.

MATERIALS

301.02.01 General. Material shall be as set forth in the special provisions.

CONSTRUCTION

301.03.01 Subgrade Preparation. The surface of the subgrade upon which the selected material is to be placed shall conform to the established lines and grade, shall be reasonably smooth and uniform and shall be compacted to the required density.

301.03.02 Placing. In producing, handling, and placing selected materials, care shall be taken to prevent segregation of the fine particles from the coarse. When the required compacted thickness is more than six (6) inches the material shall be placed in layers, none of which shall exceed six (6) inches in depth after compaction, except as provided in subsection 301.03.04, "Compaction."

After the material has been uniformly deposited, it shall be thoroughly blademixed to the full depth of the layer by alternately blading the entire layer to the center and back to the edges of the roadbed. It shall then be spread and finished to the required cross section. At the option of the Contractor, selected material may be spread with equipment meeting the requirements of subsection 303.03.03, "Spreading and Finishing."

Binder material, if required, shall be incorporated either

in the surfacing aggregate at the plant when the aggregate is produced, or shall be incorporated uniformly on the roadbed in amounts designated by the Engineer.

301.03.03 Watering. Water shall be applied prior to and during all blading operations, to moisten the material sufficiently to prevent segregation of the fine and coarse particles. Water shall also be applied during the compaction and maintenance stages in sufficient amounts to attain compaction and prevent raveling.

301.03.04 Compaction. Compaction shall immediately follow the spreading operation. Where the required thickness is six (6) inches or less, the base course may be spread and compacted in one layer. However, if vibratory compaction equipment approved by the Engineer is used, and the requirement for density is complied with, the compacted thickness of any one layer may be increased to eight (8) inches. Aggregate bases, placed on road approaches and connections, street intersection areas, median strip areas, shoulder areas, and at locations which are inaccessible to the spreading equipment, may be spread in one or more layers by any means to obtain the specified results. Each layer of material shall be compacted to ninety-five (95) percent relative maximum density as determined by Test Method No. Nev. T101 or T102. Test method to be determined by the Engineer.

It is to be expected that a loss of density in the upper portions of the material may occur due to the elements, or for a lapse in time, or for other reasons. Recompaction to the specified density will be required prior to placement of any subsequent course and no additional compensation will be allowed for such recompaction.

METHOD OF MEASUREMENT

301.04.01 Measurement. The quantity of selected material base or surface to be measured for payment will be the number of cubic yards or tons complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

301.05.01 Payment. The accepted quantity of selected material base or surfacing, measured as provided above, will be paid for at the contract unit price bid per cubic yard or ton for Selected Material Base or Surface, which price shall be full compensation for stripping the pit, crushing, screening, loading, hauling, placing, compacting, and maintaining the base or surface as shown on the plans and as directed by the Engineer.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Partial payments may be made in accordance with subsection 109.06, "Partial Payments."

Watering will be paid for in accordance with Section 210, "Watering."

Payment will be made under:

Pay Item	Pay Unit
Selected Material Base	Cubic Yard or Ton
Selected Material Surface	Cubic Yard or Ton

SECTION 302

AGGREGATE BASE COURSES

DESCRIPTION

302.01.01 General. This work shall consist of furnishing, placing, and compacting aggregate base courses constructed in accordance with the requirements hereinafter set forth and in reasonably close conformity with the lines, grades, thicknesses, and cross sections shown on the plans or established by the Engineer.

MATERIALS

302.02.01 General. All materials shall conform to the requirements as set forth in the following subsections:

Type 1 Class B Aggregate Base	Subsection 704.03.03
Type 2 Class B Aggregate Base	Subsection 704.03.05
Type 3 Class B Aggregate Base	Subsection 704.03.07
Type 1 Class A Aggregate Base	Subsection 704.03.02
Type 2 Class A Aggregate Base	Subsection 704.03.04
Type 3 Class A Aggregate Base	Subsection 704.03.06

Acceptance sampling will conform to the test requirements as set forth in the above mentioned subsections and in subsection 106.04, "Samples and Tests."

CONSTRUCTION

302.03.01 Subgrade Preparation. Any ruts, holes, defects, or soft yielding places which occur in the subgrade or subbase for any cause whatsoever shall be corrected and compacted to required density and stability before an aggregate base course is placed thereon. The above-mentioned repairs are to be made at the expense of the Contractor, except as provided for in subsection 203.03.02, "Unsuitable Material."

302.03.02 Spreading Class A Aggregates. The aggregate shall be spread in one operation with a self-propelled spreader ready for compaction without further shaping except for trimming to correct minor deficiencies

as hereinafter specified. The spreader shall be provided with a screed that strikes off and distributes the material to the required width and to the surface tolerances hereinafter set forth. The screed shall be adjustable to the required cross section. Screed action includes any cutting, oscillating, or other practical motion that produces a finished surface texture of uniform appearance. The spreader shall be self propelled and capable of spreading not less than twelve (12) feet in width. Equipment not propelled by the unloading vehicle will be considered self propelled. In narrow trench widenings, aggregate base course may be placed with self-propelled trench widening spreaders. If the spreader leaves ridges, indentations, or other objectionable marks that cannot be prevented by adjustments or eliminated by rolling, its use shall be discontinued.

Aggregate bases, placed on road approaches and connections, street intersection areas, median strip areas, shoulder areas, and at locations which are inaccessible to the spreading equipment, may be spread in one or more layers by any means to obtain the specified results.

The use of motor graders will not be permitted during depositing, spreading, and compacting operations, except as follows:

(a) Motor graders may be used to correct unavoidable segregation at edges and to trim the surface of the aggregate base after compaction in order to finish the base within the tolerances specified.

(b) When the area of the base is small or irregular, and it is impractical to use self-propelled spreading equipment, the base material may be spread by motor grader or other approved methods.

302.03.03 Spreading Class B Aggregates. The aggregate shall be uniformly deposited on the approved subgrade by means of the hauling vehicle with or without spreading devices. Aggregate will be distributed over the surface to the depth specified on the plans or established by the Engineer.

After base course material has been deposited, it shall be thoroughly blademixed to full depth of the layer by

alternately blading the entire layer to the center and back to the edges of the road. It shall then be spread and finished to the required cross section by means of a self-propelled pneumatic-tired motor grader.

At the option of the Contractor, the aggregate may be spread with a self-proplled spreader with the aggregate ready for compaction without further shaping. If this option is exercised, however, the operation shall become subject to the requirements of subsections 302.03.04, "Watering and Mixing Class A Aggregates" and 302.-03.02, "Spreading Class A Aggregates."

302.03.04 Watering and Mixing Class A Aggregates. The base course material and water shall be mixed in a mixer approved by the Engineer. Water shall be added during the mixing operation by means of spray bars in the amount necessary to provide the optimum moisture content for compacting. Attention is directed to subsection 210.03.01, "Equipment." After mixing to the extent that the product has a uniform homogeneous appearance, the base material shall be transported to the job while it contains the proper moisture content and shall be placed on the roadbed by means of an approved self-propelled aggregate spreader as provided for in subsection 302.03.02, "Spreading Class A Aggregates." If the material has dried appreciably prior to final compacting, additional water shall be added by means of a pressurized water truck to assist in compaction and to prevent raveling.

302.03.05 Watering Class B Aggregates. Water shall be applied prior to and during all blading and processing operations to moisten the material sufficiently to prevent segregation of the fine and coarse particles. Water shall be applied during the compaction and maintenance stages in sufficient amounts to assist in compaction and prevent raveling. Reference is made to Section 210, "Watering."

302.03.06 Compaction. Compaction shall immediately follow the spreading operation. Where the required thickness is six (6) inches or less, the base course may

be spread and compacted in one layer. However, if vibratory compaction equipment of a type approved by the Engineer is used, and the requirement for density is complied with, the compacted thickness of any one layer may be increased to eight (8) inches. Aggregate bases, placed on road approaches and connections, street intersection areas, median strip areas, shoulder areas, and at locations which are inaccessible to the spreading equipment, may be spread in one or more layers by any means to obtain the specified results. Each layer of material shall be compacted to ninety-five (95) percent relative maximum density as determined by Test Method No. Nev. T101 or T102. Test method to be determined by the Engineer.

It is to be expected that a loss of density in the upper portions of the material may occur due to the elements, or for a lapse in time, or for other reasons. Recompaction to the specified density will be required prior to placement of any subsequent course and no additional compensation will be allowed for such recompaction.

302.03.07 Tolerance for Type 2 Class A Aggregate. When a twelve (12) foot straightedge is laid in any direction, the finished surface shall not deviate at any point more than 0.04 foot from the bottom thereof.

METHOD OF MEASUREMENT

302.04.01 Measurement. The quantity of aggregate base to be measured for payment will be the number of cubic yards or tons complete and in place.

The weight of material will be determined by deducting from the weight of material delivered to the work, the weight of water in excess of optimum plus one percentage point. Optimum moisture will be determined by Test Method No. Nev. T101 or T102 as determined by the Engineer. Moisture content will be determined by Test Method No. Nev. T112. The weight of water thus deducted will not be measured for payment.

All water applied after the material has been weighed will be paid for in accordance with Section 210, "Watering."

Due to possible variations in the specific gravity and voids of the aggregates, the tonnage used may vary from the proposal quantities and no adjustment in contract unit price will be made because of such variation.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

302.05.01 Payment. The accepted quantity of aggregate base material, measured as provided in subsection 302.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard or ton, for the type and class specified, which price shall be full compensation for stripping the pit, crushing, screening, mixing, hauling, placing, compacting, and maintaining the base courses as shown on the plans and as directed by the Engineer.

It is to be expected that deviations in thickness will occur in placing aggregate base courses. It shall be the inherent responsibility of the Contractor to bring the various base courses to the required grade line. Payment will be limited to the number of tons or cubic yards complete and in place and no additional payment will be made for any labor or equipment used in bringing the courses to grade.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Partial payments may be made in accordance with subsection 109.06, "Partial Payments."

Watering will be paid for in accordance with Section 210, "Watering."

Payment will be made under:

Pay Item	Pay Unit
Type 1 Class B Aggregate Base (size)	Cubic Yard or Ton
Type 2 Class B Aggregate Base (size)	Cubic Yard or Ton
Type 3 Class B Aggregate Base (size)	Cubic Yard or Ton
Type 1 Class A Aggregate Base (size)	Cubic Yard or Ton
Type 2 Class A Aggregate Base (size)	Cubic Yard or Ton
Type 3 Class A Aggregate Base (size)	Cubic Yard or Ton

SECTION 303

PLANTMIX BITUMINOUS BASE

DESCRIPTION

303.01.01 General. This work shall consist of aggregate and bituminous material mixed in a central plant and spread and compacted on a prepared surface in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer.

The requirements of Section 401, "Plantmix Bituminous Pavements—General" shall be applicable to this work, except as hereinafter specified.

MATERIALS

303.02.01 General. The materials shall conform to the requirements as specified in subsections 401.02.01 through 401.02.04, inclusive, of Section 401, "Plantmix Bituminous Pavements—General."

CONSTRUCTION

303.03.01 General. The construction requirements shall conform to the requirements as specified in subsections 401.03.01 through 401.03.13, inclusive, of Section 401, "Plantmix Bituminous Pavements—General," with the following exceptions:

303.03.02 Rollers. There shall be operating with each paver, three rollers meeting the requirements of (a), (b), and (c) of subsection 401.03.04, "Rollers," except as hereinafter noted.

When two pavers are paving in echelon within four hundred (400) feet of each other and each paver is placing not more than one hundred fifty (150) tons of bituminous mixture per hour, then three rollers meeting the requirements of (a), (b), and (c) of subsection 401.03.04, "Rollers" may be used with both pavers.

303.03.03 Spreading and Finishing. Unless otherwise specified, bituminous plantmix base shall not be placed in courses exceeding four (4) inches in compacted thickness. When more than one course is placed, the courses shall be of approximately equal thickness.

303.03.04 Surface Tolerances. The completed surfacing shall be thoroughly compacted, smooth and free from ruts, humps, depressions, or irregularities. When a straightedge twelve (12) feet long is laid on the finished surface and parallel with the centerline of the highway, the surface shall not vary more than 0.02 foot from the lower edge of the straightedge. The transverse slope of the finished surface shall be uniform to a degree such that no depressions greater than 0.02 foot are present when tested with a straightedge twelve (12) feet long laid in a direction transverse to the centerline and extending from edge to edge of a twelve (12) foot traffic lane.

Any ridges, indentations, or other objectionable marks left in the surface of the bituminous mixture by blading or other equipment shall be eliminated by rolling or other means. The use of any equipment that leaves ridges, indentations, or other objectionable marks in the bituminous mixture shall be discontinued and other acceptable equipment shall be furnished by the Contractor.

METHOD OF MEASUREMENT

303.04.01 Measurement. Plantmix bituminous base will be measured as specified in subsection 401.04.01, "Measurement."

BASIS OF PAYMENT

303.05.01 Payment. The accepted quantity of materials measured as provided in subsection 303.04.01, "Measurement" will be paid for at the contract unit price bid per ton for plantmix bituminous base aggregate, per ton for mineral filler (type) and per ton for bituminous material (Asphalt Cement or Liquid Asphalt).

The above prices shall be full compensation for furnishing all the material, mixing, loading, hauling, placing,

compacting, and incidentals necessary for doing all the work involved in constructing plantmix bituminous base.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Partial payments for plantmix bituminous base aggregate may be made as set forth under subsection 109.06, "Partial Payments."

Payment will be made under:

Pay Item	Pay Unit
Plantmix Bituminous Base Aggregate	Ton
Mineral Filler (type)	Ton
Asphalt Cement (grade)	Ton
Liquid Asphalt (grade)	Ton

SECTION 304

PORTLAND CEMENT TREATED BASE

DESCRIPTION

304.01.01 General. This work shall consist of constructing one or more courses of a mixture of aggregate and Portland cement on a prepared surface in accordance with these specifications in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer.

The method to be used, either plantmix or roadmix, shall be designated in the contract documents.

MATERIALS

304.02.01 General. All material shall conform to the requirements specified in the following sections:

Portland Cement	Section 701
Water	Section 722
Aggregate for Portland Cement Treated Base	Subsection 704.03.08
Liquid Asphalt	Subsection 703.03.03
Emulsified Asphalt	Subsection 703.03.04

CONSTRUCTION

304.03.01 Proportioning. Portland cement shall be applied to the mineral aggregate at not less than two (2) percent nor more than four and one-half (4½) percent of the weight of the dry mineral aggregate. Any allowable variations hereinafter set forth are to be inclusive of the above stated percentages. The exact rate of application of cement shall be as determined by the Engineer. Immediate control of the cement content shall be accomplished by testing the fresh, moist cement aggregate mixture, by Test Method No. Nev. T518.

304.03.02 Mixing—Roadmix Method. (a) Depositing Untreated Aggregate. Untreated aggregate shall be deposited on the prepared area by means of spreader boxes equipped with a readily adjustable strike-off device

resulting in a uniform windrow or a uniform spread, to provide the required width and surface tolerance specified in subsection 304.03.06, "Finished Surface." Aggregate to be treated shall not be mixed with roadbed material that is not to be treated.

(b) Mixing. Cement treated base may be mixed either on the roadbed or at a location off the roadbed by the roadmixed method, or the plantmixed method as the Contractor may elect.

If the Contractor elects to use the plantmixed method, all the requirements in subsection 304.03.03, "Mixing—Plantmix Method," will apply, except the following:

1. The separation of aggregates into two sizes and storing in separate stockpiles as provided in subsection 304.03.03, "Mixing—Plantmix Method," will not be required.
2. The 0.4 of a percentage point variation in the cement content as provided in subsection 304.03.03, "Mixing—Plantmix Method," will be increased to 0.6 of a percentage point as specified in this subsection.

If the Contractor elects to use the roadmixed method, the roadmixing machine shall be of the pugmill or auger type. The machine shall be designed to pick up the material to be mixed from a windrow or blanket and shall be equipped with a bottom shell or pan so that during at least fifty (50) percent of the mixing cycle all the material is picked up and mixed while separated from the mixing table.

Cement to be mixed with aggregate may be furnished in sacks or in bulk. If sacked cement is used, the sacks shall be distributed on the aggregate at the required intervals and then be emptied by hand methods following which the cement from each sack shall be distributed in a layer of uniform thickness. If the cement is furnished in bulk, it shall be spread by mechanical equipment. Each load in the spreading equipment shall be calibrated so the average rate of spread can be determined by the Engineer. The rate of cement spread per linear foot of windrow or blanket

shall not vary more than ten (10) percent from the designated rate. The tops of windrowed aggregate shall be flattened or slightly trenched to receive the cement. The distance which cement may be spread upon the aggregate ahead of the roadmixing operations will be determined by the Engineer.

The roadmixing machine shall have provisions for introducing water at the time of mixing, through a metering device or by other approved methods. The water shall be applied by means of controls that will supply the correct quantity of water to produce a completed mixture with a uniform moisture content. Leakage of water from equipment will not be permitted. Care shall be exercised to avoid the addition of any excessive water. The quantity of water added to the mixture will be determined by the Engineer.

Where the material is to be spread and compacted in two or more layers, material for each layer shall be mixed separately.

The resulting mixture shall be uniform and more than one pass of the mixer through the material may be required. If equipment is used that requires more than one pass of the mixer, at least one pass shall be made before any water is added to the material.

The cement content of samples taken from time to time from the product of the roadmixing machine, or from mixtures spread on the roadbed shall not have a variation above or below the cement content designated by the Engineer or more than 0.6 of a percentage point based on the weight of the aggregate as determined by Test Method No. Nev. T518.

The lengths of treated sections shall be regulated to permit completion within the time requirements provided in subsection 304.03.07, "Time Requirements."

Should the Contractor elect to perform roadmixing operations off the roadbed, the provisions specified in this subsection for mixing on the roadbed shall apply.

304.03.03 Mixing—Plantmix Method. (a) General. Cement treated base shall be mixed at a central mixing

plant by either batch mixing using revolving blade or rotary drum mixers or continuous mixing at the option of the Contractor. The aggregate and cement may be proportioned either by weight or volume. Aggregate for cement treated base shall be separated into two sizes and each size shall be stockpiled separately. One stockpile shall contain aggregate retained on a No. 4 sieve of which not more than twenty (20) percent shall be finer than a No. 4 sieve. The other stockpile shall contain aggregate of which at least eighty (80) percent is finer than the No. 4 sieve. If aggregates are separated into more than two sizes, any combination of sizes approved by the Engineer that will meet the grading and other test requirements will be acceptable.

In all plants, the water shall be proportioned by weight or volume and there shall be means by which the Engineer may readily verify the amount of water per batch or the rate of flow for continuous mixing. The time of the addition of water or the points at which it is introduced into the mixer, shall be determined by the Engineer. The quantity of water added to the mixture will be determined by the Engineer.

In all plants, cement shall be added in such a manner that it is uniformly distributed throughout the aggregates during the mixing operation.

The charge in a batch mixer, or the rate of feed to a continuous mixer, shall not exceed that which will permit complete mixing of all of the material. Dead areas in the mixer, in which the material does not move or is not sufficiently agitated, shall be corrected by either a reduction in the volume of material or by other adjustment.

In all plants, the proportioning of materials designated by the Engineer shall be within the following tolerances:

Aggregate weights or rate of feed	± 5.0%
Cement content of the complete dry mixture	± 0.4%
Moisture content of the completed mixture	± 1.0%

The Contractor shall furnish weighing equipment as specified in subsection 109.01, "Measurement of Quantities."

(b) Batch Mixing. In batch type mixers the mixer shall be equipped with a timing device which will indicate by a definite audible or visual signal the expiration of the mixing period. The device shall be accurate to within two (2) seconds. The plant shall be equipped with a suitable automatic device for counting the number of batches.

Mixing shall continue until a homogeneous mixture of uniformly distributed and properly coated aggregates of unchanging appearance is produced.

Cement for each batch shall be weighed on scales separate and distinct from the aggregate batching scales.

If volumetric proportioning is used, means shall be provided for accurately calibrating the amount of material in each measuring bin.

(c) Continuous Mixing. If the continuous type mixer is used, the correct proportion of each aggregate size introduced into the mixer shall be drawn from the storage facility by an approved type of feeder, which will continuously supply the correct amount of aggregate in proportion to the cement, and so arranged that the proportion of each aggregate size can be separately adjusted. The plant shall be equipped with metering devices of an approved type that will introduce the cement and water into the mixer in specified proportions. The metering devices and feeder shall be interlocked and so synchronized as to maintain a constant rate of cement and water to the aggregate. When storage bins are used, they shall be equipped with overflow chutes for each compartment. A positive signal system shall be provided that will automatically close down the plant when the level of material in any bin approaches the strike-off capacity of the feed gate. The plant shall not be permitted to operate unless the signal system is in good working condition. The feeder for the aggregate shall be mechanically or electrically driven. Aggregate feeders that are mechanically driven shall be directly connected with the drive on the cement feeder. The plant shall be equipped with facilities satisfactory to the Engineer for calibrating gate openings and metering devices by weighing check samples. Aggregate feeders that are electrically driven shall be actuated from

the same circuit that serves the motor driving the cement feeder.

Mixing shall continue until a homogeneous mixture of uniformly distributed and properly coated aggregates of unchanging appearance is produced.

The cement feeder shall be equipped with a device by which the rate of cement feed can be determined while the plant is in full operation.

304.03.04 Spreading. (a) General. The area to be covered with cement treated base shall be prepared and compacted to the grade and cross section for the bottom surface of the cement treated base. Any material cut away in trimming for such grade and cross section shall be disposed in a manner satisfactory to the Engineer.

Materials mixed at a location off the roadbed shall be protected against moisture loss while being transported to the spreading site, with a method approved by the Engineer, and shall be spread without segregation. Immediately prior to spreading, the area to be covered shall be moistened and kept moist, but not excessively wet.

Where the required thickness is six (6) inches or less, the mixture may be spread and compacted in one layer. Where the required thickness is more than six (6) inches, the mixture shall be spread and compacted in two or more layers of approximately equal thickness and the maximum compacted thickness of any one layer shall not exceed six (6) inches. Work on each layer shall be performed in a similar manner and the surface of the compacted material shall be kept moist or prevented from drying by some method approved by the Engineer until covered with the next layer.

Cement treated base to be placed in inaccessible areas may be spread by approved methods in one course. After spreading, the material shall be thoroughly compacted to the required lines, grades, and cross section by means of pneumatic tampers or with other compacting equipment which consistently obtains equal or better com-

paction than that provided in subsection 304.03.05, "Compaction."

(b) Plantmix Method. The mixture shall be deposited on the roadbed at a uniform quantity per linear foot, which quantity will provide the required compacted thickness without resorting to spotting, picking up, or otherwise shifting the mixture.

The mixture shall be spread in one operation with a self-propelled mechanical spreader ready for compaction without further shaping. Segregation shall be avoided and the base shall be free from pockets of coarse or fine material. Equipment not propelled by the unloading vehicle will be considered self propelled. The spreader shall be provided with a screed that strikes off and distributes the material to the required width and to the surface tolerances specified in subsection 304.03.06, "Finished Surface." The screed shall be adjustable to the required cross section. Screed action includes any cutting, oscillating or other practical motion that produces a finished surface texture of uniform appearance. If the spreader leaves ridges, indentations, or other objectionable marks in the surface that cannot be eliminated by rolling, or prevented by adjustments in operation, its use shall be discontinued.

Except as otherwise provided in this subsection, the use of motor graders will not be permitted during spreading and compacting operations, except that motor graders may be used to trim the edges and surface of the cement treated base after compaction in order to finish the base within the tolerances specified.

The mixed materials shall be spread for the full planned width, either by one spreader or by several spreaders operating in a staggered position across the subgrade, unless otherwise permitted by the Engineer or if traffic conditions require part width construction. Should permission be granted or part width construction be required for the use of one spreader operating alternately on contiguous lanes, not more than one (1) hour shall elapse between the time of placing material in adjacent lanes at any location.

If longitudinal construction joints are necessary, they shall fall on lane lines.

304.03.05 Compaction. The provisions contained in this subsection apply to both plantmix and roadmix methods.

Compacting equipment shall produce the required compaction within the operation time limit specified in subsection 304.03.07, "Time Requirements."

Initial rolling of cement treated bases shall be performed with steel-tired rollers.

Rolling shall be performed in such a manner that bumps and irregularities will be eliminated and the finished surface shall be true to the required grade and cross section within the surface tolerances specified in subsection 304.-03.06, "Finished Surface."

Water shall be applied without driving equipment over the uncompacted material.

Rolling shall commence by completely covering the outer edge of the material. Subsequent rolling shall lap at least twenty-five (25) percent of previously compacted material.

Pneumatic-tired rollers conforming to the provisions in subsection 401.03.04, "Rollers," shall be used following completion of initial rolling.

Areas inaccessible to rollers shall be compacted to the required compaction by other means.

The density of compacted cement treated bases shall not be less than ninety-five (95) percent of the maximum density determined by Test Method No. Nev. T101 or T-102. Test method to be determined by the Engineer.

304.03.06 Finished Surface. The finished surface of cement treated base shall be uniform and shall not deviate at any point more than 0.03 foot from the bottom of a twelve (12) foot straightedge laid in any direction.

The surface of the finished cement treated base at any point shall not vary more than 0.05 foot above or below the grade established by the Engineer, except that when Portland cement concrete pavement is to be placed on cement treated base, the surface of the finished cement

treated base at any point shall not extend above the grade established by the Engineer.

When the finished surface of cement treated base is outside the specified tolerances and before placing any course of material thereon, all high spots on the finished surface shall be trimmed off to within the specified tolerance. The excess material shall be removed and disposed of in a manner approved by the Engineer immediately after trimming and no loose material shall be left on the base and the area shall then be rolled again. Full compensation for trimming high spots and disposing of the trimmed material shall be considered as included in the prices paid for the contract items involved in constructing the cement treated base and no additional compensation will be allowed therefor.

Cleated equipment shall not be allowed on new cement treated base unless street pads are used on cleats.

304.03.07 Time Requirements. Any mixture of aggregate, cement, and water that has not been compacted shall not be left undisturbed for more than thirty (30) minutes. Not more than two (2) hours shall elapse between the time water is added to the aggregate and cement and the time of completion of initial rolling. Not more than three (3) hours shall elapse between the time water is added to the aggregate and cement and the time of completion of final compaction after trimming.

304.03.08 Construction Joints. At the end of each day's work and when cement treated base operations are delayed or stopped for more than two (2) hours, a construction joint shall be made in thoroughly compacted material, normal to the centerline of the roadbed with a vertical face. Additional mixture shall not be placed until the construction joint has been approved by the Engineer.

Where cement treated base has been finally compacted more than one (1) hour, longitudinal joints shall be constructed by cutting vertically into the existing edge for approximately three (3) inches and the material cut away may be disposed of in the adjacent lane to be constructed.

The face of the cut joints shall be moistened in advance of placing the adjacent base.

304.03.09 Protection and Curing. The surface shall be kept moist at all times until the curing seal is applied. Water equipment shall be of a type which will apply moisture in a fog or mist type application free of pressure at the surface being treated.

The completed cement treated base shall be covered with a bituminous curing seal as protection against drying. Curing seal will be required only for the top layer of cement treated base. The curing seal shall be applied as soon as possible, but not later than eight (8) hours after the completion of final rolling. The surface shall be kept moist until the seal is applied. Curing seal shall be Liquid Asphalt, Type MC-250, unless otherwise specified, and shall be applied at a rate of between 0.15 gallon and 0.25 gallon per square yard of surface, the exact amount to be determined by the Engineer. The curing seal shall be applied in accordance with the requirements of Section 407, "Seal Coat," and in sufficient quantity to provide a continuous membrane over the base. At the time of application of the curing seal, the surface shall be tightly knit, free from all loose material and shall contain sufficient moisture to prevent excessive penetration of the asphalt. If necessary to insure this, sufficient water to fill the surface voids shall be applied immediately before the asphalt is applied.

Equipment or traffic shall not be permitted on the cement treated base during the first three (3) days after applying the curing seal, unless otherwise permitted by the Engineer. After traffic is allowed on the cement treated base, and there is danger of excessive surface abrasion, sand blotter may be required as determined by the Engineer.

When equipment or traffic is permitted on the cement treated base and such permission is granted for the sole convenience of the Contractor, he shall protect the curing seal at his expense.

All loose sand shall be completely removed from the

cement treated base before any surfacing material is placed thereon. Full compensation for furnishing, spreading, and removing sand as specified above shall be considered as included in the contract price paid for sand blotter and no additional allowance will be made therefor.

304.03.10 Weather Limitations. Cement treated base shall not be mixed or placed while the atmospheric temperature is below thirty-five (35) degrees Fahrenheit, or when conditions indicate that the temperature will fall below thirty-five (35) degrees Fahrenheit for a sustained period of four (4) hours. Cement treated base shall not be placed on frozen ground and all material shall be protected from freezing and frost for a period of five (5) days after placing.

METHOD OF MEASUREMENT

304.04.01 Roadmix Method Designated for Use. The quantity of cement treated base aggregate to be measured for payment will be the number of tons, conforming to all the requirements in the completed work. When aggregate and other materials are mixed at a central mixing plant, the quantity of aggregate will be determined by weighing the completed mixture of aggregate cement and water, and deducting from this weight the weight of the cement and water. Water shall be metered and meters shall be calibrated for weight as prescribed in subsection 109.01, "Measurement of Quantities." Mixing, hauling, spreading, and compacting cement treated bases will be measured for payment by the square yard. Area will be determined from horizontal measurement of the finished surface of the base.

Portland cement will be measured for payment by the barrel. A barrel of cement will be considered as weighing three hundred seventy-six (376) pounds. Weighing may be done by sack count (ninety-four (94) pounds to the sack) or by scale weights obtained by weighing the spreading equipment before and after spreading the cement when roadmixed, or by scale weights when the mixture is plantmixed.

304.04.02 Plantmix Method Designated for Use. The quantity of plantmix cement treated base aggregate to be measured for payment will be the number of tons, conforming to all the requirements, in the completed work, less the weight of cement. This will be determinined by weighing the completed mixture of aggregate, cement and water (in the hauling vehicle prior to delivery), and by deducting from this weight the weight of cement.

Portland cement will be measured for payment by the barrel. One barrel of cement will be considered as weighing three hundred seventy-six (376) pounds. Weighing may be done by sack count (ninety-four (94) pounds to the sack) or by scale weights.

304.04.03 General. For both roadmix and plantmix methods, the quantities of liquid asphalt used for curing seal and sand blotter to be measured for payment will be determined as provided in Section 407, "Seal Coat."

The quantity of Portland cement to be measured for payment may be determined from certified weight certificates indicating the truck and trailer number, tare weight, gross weight, net weight, and date. When the measurement of Portland cement is based on certified weight certificates, the following requirements shall apply:

(a) An occasional loaded transporting vehicle shall be weighed by project personnel prior to discharge of any material. The Engineer will determine the frequency in which the loaded vehicles are weighed.

(b) Every empty transporting vehicle shall be weighed by project personnel prior to the vehicle leaving the project.

(c) The Engineer will be the sole judge in determining the quantity of Portland cement used should a discrepancy arise between project weights of the loaded or unloaded vehicles or both and the certified weight certificates.

Due to possible variations in the specific gravity and voids of the aggregates, the tonnage used may vary from

the proposal quantities and no adjustment in contract unit price will be made because of such variation.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

304.05.01 Roadmix Method Designated for Use. The accepted quantity of materials measured as provided in subsection 304.04.01, "Roadmix Method Designated for Use" will be paid for at the contract unit price bid per barrel for "Portland Cement," per ton for "Roadmixed Cement Treated Base Aggregate" and per square yard for "Mixing Cement Treated Base."

The above prices shall be full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all the work involved in constructing roadmixed cement treated base, complete in place as shown on the plans and as directed by the Engineer.

The State reserves the right to increase or decrease the estimated amount of cement. Adjustment of unit price will not be made for such increase or decrease.

Payment will be made under:

Pay Item	Pay Unit
Roadmix Cement Treated Base Aggregate (dry)	Ton
Portland Cement for Cement Treated Base	Barrel
Mixing Cement Treated Base	Square Yard

304.05.02 Plantmix Method Designated for Use. The accepted quantity of materials measured as provided in subsection 304.04.02, "Plantmix Method Designated for Use," will be paid for at the contract unit price bid per barrel for "Portland Cement" and per ton for "Plantmix Cement Treated Base Aggregate," which prices shall be full compensation for stripping the pit, crushing, screening, loading, hauling, furnishing water for the mix, mixing, placing, trimming, and compacting, complete in place as shown on the plans and as directed by the Engineer.

Payment will be made under:

Pay Item	Pay Unit
Plantmix Cement Treated Base Aggregate (wet)	Ton
Portland Cement for Cement Treated Base	Barrel

304.05.03 General. The accepted quantities of "Liquid Asphalt" used for curing seal and "Sand Blotter," will be paid for in accordance with Section 407, "Seal Coat."

For both the roadmix and plantmix methods, all payments will be made in accordance with subsection 109.02, "Scope of Payment."

Partial payments for "Roadmix Cement Treated Base Aggregate" or "Plantmix Cement Treated Base Aggregate" may be as set forth under subsection 109.06, "Partial Payments."

Watering will be paid for in accordance with Section 210, "Watering."

SECTION 401

PLANTMIX BITUMINOUS PAVEMENTS—GENERAL

DESCRIPTION

401.01.01 General. These specifications include general requirements that are applicable to all types of bituminous pavements of the plantmix type irrespective of gradation of aggregate, kind and amount of bituminous material, or pavement use. Deviations from these general requirements will be indicated in the specific requirement for each type.

This work shall consist of one or more courses of bituminous mixture constructed on the prepared foundation in accordance with these specifications and the specific requirements of the type under contract, and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer.

MATERIALS

401.02.01 Composition of Mixtures. The bituminous plantmix shall be composed of a mixture of aggregate, filler if required, and bituminous material. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that the resulting mixture meets the grading requirements of the job-mix formula.

Before starting work, the Contractor shall submit a proposed job-mix formula in writing, for use by the Engineer in setting the job-mix to be used. The formula submitted shall propose definite single values for:

(a) The percentage of aggregate passing each specified sieve.

(b) The percentage of bitumen to be added (to 0.1 percent).

(c) The temperature of the mixture leaving the mixer.

(d) The temperature of the mixture in the hopper of the paving machine.

The job-mix formula with the allowable tolerances shown herein shall conform to the requirements of Section 705, "Aggregates for Bituminous Courses," for plantmix bituminous base aggregate, plantmix bituminous surface aggregate, or plantmix bituminous open-graded aggregate, as the case may be.

The Engineer will determine a job-mix formula with single values for (a), (b), (c), and (d) above and so notify the Contractor in writing. This job-mix formula shall be in effect until modified in writing by the Engineer. The mixture furnished shall conform to this job-mix formula, within the following range of tolerances:

Aggregate passing the No. 4, and larger sieves	±7%
Aggregate passing the No. 8 to 100 sieves	±4%
Aggregate passing the No. 200 sieve	±2%
Bitumen content	±0.3% of volume or batch weight of aggregate
Temperature leaving the mixer	±20 deg. F.
Temperature in hopper of paving machine	±20 deg. F.

Should there be a change in sources of material, a new job-mix formula will be established before the new material is used. When unsatisfactory results make it necessary, the Engineer may establish a new job-mix formula and so notify the Contractor in writing.

Temperatures of asphalt cement shall be within the following ranges:

Grade and Type Pen	—Pugmill Temperature— Minimum	Maximum
40–50	300	350
60–70	275	325
85–100	275	325
120–150	275	325
200–300	225	275

The temperature of base and surface mixtures at the point of discharge shall have a minimum of two hundred twenty-five (225) degrees Fahrenheit and a maximum of three hundred twenty-five (325) degrees Fahrenheit. The temperature of base and surface mixtures at the hopper of the paver shall not be less than two hundred twenty-five (225) degrees Fahrenheit.

Particular care shall be taken during manufacture of open-graded mixtures to prevent overheating or "burning" of the mixture, and the temperature of the mineral aggregate shall not be in excess of two hundred ninety (290) degrees Fahrenheit. The temperature of the open-graded mixture at the hopper of the paver shall not be less than two hundred (200) or more than two hundred sixty (260) degrees Fahrenheit.

For mixtures containing liquid asphalt the temperatures shall be within the following ranges:

Grade and Type MC and SC	—Pugmill Temperature— Minimum	Maximum
70	90	155
250	125	200
800	160	225
3000	200	260

The type and grade of bituminous material will be specified in the contract. The grade may be changed one step by the Engineer at no change in unit price.

Attention is directed to subsection 106.03, "Samples and Tests."

401.02.02 Aggregates. Aggregates shall meet the applicable requirements of Section 705, "Aggregates for Bituminous Courses."

401.02.03 Commercial Mineral Filler. Commercial mineral filler shall meet the requirements of subsection 705.03.03, "Commercial Mineral Filler."

401.02.04 Bituminous Materials. The bituminous material shall meet the applicable requirements of Section 703, "Bituminous Materials." Bituminous material may be conditionally accepted at the source.

CONSTRUCTION

401.03.01 Bituminous Mixing Plant. Sufficient storage space shall be provided for the aggregate, or for each size aggregate when required. The storage yard shall be maintained neat and orderly and the stockpile, or separate

stockpiles when required, shall be readily accessible for sampling.

Plants used for the preparation of bituminous mixtures shall conform to all requirements under (a) except that scale requirements shall apply only where weight proportioning is used. In addition, batch mixing plants shall conform to the requirements under (b); and continuous mixing plants shall conform to the requirements under (c).

(a) Requirements for all plants. Mixing plants shall be of sufficient capacity and co-ordinated to adequately handle the proposed bituminous construction.

1. Plant scales. Scales shall be accurate to 0.5 percent of the maximum load that may be required. Poises shall be designed to be locked in any position to prevent unauthorized change of position. In lieu of plant and truck scales, the Contractor may provide an approved automatic printer system which will print the weights of the material delivered, provided the system is used in conjunction with an approved automatic batching and mixing control system. Such weights shall be evidenced by a weigh ticket for each load.

Scales shall be inspected and certified as often as the Engineer may deem necessary to assure their continued accuracy. The Contractor shall have on hand not less than ten fifty (50) pound weights for testing the scales.

The amount of filler material shall be determined by weighing on springless dial scales separate from the plant weigh hopper or by some method that uniformly feeds the mixer within ten (10) percent of the required amount.

2. Equipment for preparation of bituminous material. Tanks for the storage of bituminous material shall be equipped to heat and hold the material at the required temperatures. The heating shall be accomplished by steam coils, electricity, or other approved means so that no flame shall be in contact with the tank. The circulating system for the bituminous material shall be designed to assure proper and continuous circulation during the operating period. Provision shall be made for measuring and sampling storage tanks.

3. Feeder for drier. The plant shall be provided with accurate mechanical means for uniformly feeding the aggregate into the drier so that uniform production and uniform temperature will be obtained.

4. Drier. The plant shall include a drier or driers which continuously agitate the aggregate during the heating and drying process. For cold type bituminous mix, equipment for mechanical cooling of the dried aggregate to the temperature prescribed for cold mixtures shall be provided and shall be capable of supplying prepared material for the mixer to operate at full capacity.

5. Screens. Plant screens, capable of screening all aggregates to the specified sizes and proportions and having normal capacities in excess of the full capacity of the mixer, shall be provided.

6. Bins. The plant shall include storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. Bins shall be arranged to assure separate and adequate storage of appropriate fractions of the mineral aggregates. Separate dry storage shall be provided for mineral filler when used and the plant shall be equipped to feed such material into the mixer. Each bin shall be provided with overflow pipes, of such size and at such locations as to prevent backing up of material into other compartments or bins. Each compartment shall be provided with its individual outlet gate, constructed so that when closed there shall be no leakage. The gates shall cut off quickly and completely. Bins shall be so constructed that samples can be readily obtained. Bins shall be equipped with adequate telltale devices on continuous mix plants to indicate the position of the aggregates in the bins at the lower quarter points.

7. Bituminous control unit. Satisfactory means, either by weighing or metering, shall be provided to obtain the proper amount of bituminous material in the mix within the tolerance specified. Means shall be provided for checking the quantity or rate of flow of bituminous material into the mixer.

8. Thermometric equipment. An armored thermometer of adequate range in temperature reading shall

be fixed in the bituminous feed line at a suitable location near the charging valve at the mixer unit.

The plant shall also be equipped with either an approved dial-scale, mercury-actuated thermometer, an electric pyrometer, or other approved thermometric instrument so placed at the discharge chute of the drier as to register automatically or indicate the temperature of the heated aggregates.

The Engineer may require replacement of any thermometer by an approved temperature-recording apparatus for better regulation of the temperature of aggregates.

9. Dust Collector. The plant shall be equipped with a dust collector constructed to waste or return uniformly to the hot elevator all or any part of the material collected as directed by the Engineer.

10. Truck scales. Except as allowed in subsection 401.04.01, "Measurement," bituminous mixture shall be weighed on approved scales furnished by the Contractor or on public scales at the Contractor's expense. Such scales shall be platform scales and conform to the provisions of subsection 109.01, "Measurement of Quantities."

11. Safety Requirements. Adequate and safe stairways to the mixer platform and sampling points shall be provided and guarded ladders to other plant units shall be placed at all points where accessibility to plant operations is required. Accessibility to the top of truck bodies shall be provided by a platform or other suitable device to enable the Engineer to obtain sampling and mixture temperature data. A hoist or pully system shall be provided to raise scale calibration equipment, sampling equipment, and other similar equipment from the ground to the mixer platform and return. All gears, pulleys, chains, sprockets, and other dangerous moving parts shall be thoroughly guarded and protected. Ample and unobstructed passage shall be maintained at all times in and around the truck loading area. This area shall be kept free from drippings from the mixing platform.

(b) Requirements for batching plants.

1. Weigh box or hopper. The equipment shall include a means for accurately weighing each size of aggregate in a weigh box or hopper suspended on scales and of ample size to hold a full batch without hand raking or running over. The gate shall close tightly so that no material is allowed to leak into the mixer while a batch is being weighed.

2. Bituminous control. The equipment used to measure the bituminous material shall be accurate to plus or minus 0.5 percent. The bituminous material bucket shall be a non-tilting type with a loose sheet metal cover. The length of the discharge opening or spray bar shall be not less than three-fourths the length of the mixer and it shall discharge directly into the mixer. The bituminous material bucket, its discharge valve or valves, and spray bar shall be adequately heated. Steam jackets, if used, shall be efficiently drained and all connections shall be so constructed that they will not interfere with the efficient operation of the bituminous scales. The capacity of the bituminous material bucket shall be at least fifteen (15) percent in excess of the weight of bituminous material required in any batch. The plant shall have an adequately heated quick-acting, non-drip, charging valve located directly over the bituminous material bucket.

Bituminous material shall be measured by means of springless dial scales or metering devices. Springless dial scales shall have a capacity of not more than one thousand (1,000) pounds in two (2) pound graduations. The indicator dial shall have a capacity of at least fifteen (15) percent in excess of the quantity of bituminous material used in a batch. The controls shall be constructed so that they may be locked at any dial setting and will automatically reset to that reading after the addition of bituminous material to each batch. The dial shall be in full view of the mixer operator. The flow of bituminous material shall be automatically controlled so that it will begin when the dry mixing period is over. All of the bituminous material required for one batch shall be discharged in not more than fifteen (15) seconds after the flow has started. The

size and spacing of the spray bar openings shall provide a uniform application of bituminous material the full length of the mixer. The section of the bituminous line between the charging valve and the spray bar shall be provided with a valve and outlet for checking the meter when a metering device is substituted for a bituminous material bucket.

3. Mixer. The batch mixer shall be of a twin pugmill type, steam jackets, or heated by other approved means and capable of producing uniform mixtures within the specified tolerances. It shall be equipped with a sufficient number of paddles or blades set in proper order and operated at such speed as to produce a properly and uniformly mixed batch. The clearance of the paddles or blades from all fixed and moving parts shall not exceed one (1) inch. Badly worn or defective paddles or blades shall not be used in mixing operations.

4. Control of Mixing Time. The mixer shall be equipped with an accurate time lock to control the operations of a complete mixing cycle. It shall lock the weigh box gate after the charging of the mixer until the closing of the mixer gate at the completion of the cycle. It shall lock the bituminous material bucket throughout the dry mixing period and shall lock the mixer gates throughout the dry and wet mixing periods. The dry mixing period is defined as the interval of time between the opening of the weigh box gate and the start of introduction of bituminous material. The wet mixing period is the interval of time between the start of introduction of bituminous material and the opening of the mixer gate.

The mixer shall be equipped with a timing device which will indicate by a definite audible or visual signal the expiration of the mixing period. The device shall measure the time of mixing within an accuracy of two (2) seconds. A suitable automatic device for counting the number of batches shall be provided and maintained in proper working condition. Attention is directed to subsection 401.-03.09, "Mixing" for timing cycles.

(c) Requirements for continuous mixing plants.

1. Aggregate proportioning. The plant shall include means for accurately proportioning each size of aggregate.

The plant shall have a feeder mounted under each compartment bin. Each compartment bin shall have an accurately controlled individual gate to form an orifice for volumetrically measuring the material drawn from each compartment. The feeding orifice shall be rectangular with one dimension adjustable by positive mechanical means provided with a lock

Indicators shall be provided for each gate to show the respective gate opening in inches.

Commercial filler material introduced into the mixer shall be drawn from the storage bins by a continuous mechanical or electrical feeder which will uniformly feed the mixer within ten (10) percent of the required amount.

2. Weight calibration of aggregate feed. The plant shall include a means for calibration of gate openings by weighing test samples. Provision shall be made so that materials fed out of individual orifices may be bypassed to individual test boxes. The plant shall be equipped to conveniently handle individual test samples weighing not less than five hundred (500) pounds. Accurate scales shall be provided by the Contractor to weigh such test samples.

3. Bitumen pump. The bituminous material shall be introduced into the mixer through an indicating meter by a positive displacement type of pump. A means shall be provided to maintain the pressure constant on each side of the pump. Gauges shall be installed for checking said pressures. The pump shall be equipped with a ready means of varying the rate of delivery of bituminous material.

4. Synchronization of aggregate feed and bituminous material feed. Satisfactory means shall be provided to afford positive interlocking control between the flow of aggregate from the bins and the flow of bituminous material from the meter or other proportioning device. A positive signal system shall be provided to indicate the level of material in each bin and as the level of material

in any one bin approaches the strike-off capacity of the feed gate, the device will automatically close down the plant instantly. The plant shall not be permitted to operate unless this automatic signal system is in good working condition.

5. Mixer. The plant shall include a continuous mixer of an approved type, adequately heated and capable of producing a uniform mixture within the job-mix tolerances. It shall be equipped with a discharge hopper with dump gates which will permit rapid and complete discharge of the mixture. The paddles shall be adjustable for angular position on the shafts and reversible to retard the flow of the mix. The mixer shall have a manufacturer's plate giving the net volumetric contents of the mixer at the several heights inscribed on a permanent gauge. Charts shall be provided showing the rate of feed of aggregate per minute for the aggregate being used.

In order to avoid segregation of coarse particles from the stream of continuous discharge, the mixer shall be equipped with a discharge hopper holding approximately one thousand (1,000) pounds and discharging intermittently.

401.03.02 Hauling Equipment. Trucks used for hauling bituminous mixtures shall have tight, clean, smooth metal beds which have been thinly coated with a minimum amount of paraffin oil, lime solution, or other approved material to prevent the mixture from adhering to the beds.

401.03.03 Pavers. Bituminous pavers shall be self-contained, power-propelled units, provided with an activated screed or strike-off assembly, heated if necessary, and capable of spreading and finishing courses of bituminous plantmix material in lane widths applicable to the specified typical section and thicknesses shown on the plans. Pavers used for shoulders and similar construction shall be capable of spreading and finishing courses of bituminous plantmix material in widths shown on the plans.

Pavers shall be equipped with a receiving hopper having sufficient capacity for a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed.

The screed or strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

The screed shall be equipped with automatic controls which will make adjustment in both transverse and longitudinal directions. The sensing device shall be adaptable to picking up grade information from a stringline, rail, ski, or adjacent strip of pavement. In the event of failure of the automatic controls the Contractor will be permitted to finish the half shift, but not to exceed four (4) hours, using manual controls. Operations shall not resume until the controls are repaired.

401.03.04 Rollers. Rollers shall meet the following requirements:

(a) Breakdown rollers shall be either a three (3) wheeled steel roller or a two-axle tandem or a three-axle tandem weighing not less than ten (10) tons.

(b) Pneumatic-tired rollers shall consist of not less than nine (9) wheels equipped with pneumatic tires of equal size and diameter mounted on two axles attached to a rigid frame equipped with a loading platform or body suitable for ballast loading; so that the total weight of the roller can be varied to produce an operating weight per tire of between one thousand (1,000) and two thousand (2,000) pounds. The tires shall have treads satisfactory to the Engineer. The tires on the rear axle shall be so spaced that the entire gap between adjacent tires on the front axle will be covered by one tread of the following tires. The tires shall be uniformly inflated so that the air pressure in the several tires will not vary more than five (5) pounds per square inch. Inflation pressure in pounds per square inch shall be the tire manufacturer's recommendation. Minimum tire size shall be 7.50 x 15 inches, four (4) ply.

(c) The finish roller shall be a two-axle tandem weighing not less than eight (8) tons.

Attention is directed to subsection 401.03.11, "Rolling."

401.03.05 Weather Limitations. Plantmix bituminous base or surface shall not be placed on any wet surface or when the air temperature is below forty (40) degrees Fahrenheit or when weather conditions otherwise prevent the proper handling or finishing of the bituminous mixtures.

The open-graded plantmix surface shall be placed only when the pavement surface temperature in the shade is above sixty (60) degrees Fahrenheit.

401.03.06 Preparation of Existing Surface. When the surface of the existing pavement or old base is irregular, it shall be brought to uniform grade and cross section as directed.

When specified in the contract, all longitudinal and transverse joints and all cracks shall be sealed by the application of an approved joint sealing compound before spreading the mixture upon a Portland cement concrete surface. All excess bituminous material shall be removed from joints and cracks prior to spreading the mixture.

Contact surface of curbing, gutters, manholes, and other structures shall be painted with a thin, uniform coating of asphaltic emulsion prior to the bituminous mixture being placed against them.

401.03.07 Preparation of Bituminous Materials. The bituminous material shall be heated to the specified temperature in a manner that will avoid local overheating and provide a continuous supply of the bituminous material to the mixer at a uniform temperature at all times.

401.03.08 Preparation of Aggregates. Type 4 plantmix surface aggregate shall be separated and stored in two separate stockpiles. One stockpile shall contain material of such size that a minimum of eighty (80) percent will pass a No. 4 sieve and the other stockpile shall contain material

of such size that a minimum of eighty (80) percent will be retained on a No. 4 sieve. The different aggregate sizes shall be kept separated until they have been delivered to the cold elevator feeding the drier. Plantmix surface aggregate shall be stockpiled prior to delivery to the drier. The quantity required to be in stockpile(s) shall at all times be such that a uniform mixture meeting all the grading requirements may be evenly fed to the drier. Hot plant operations shall not be commenced until a minimum of five thousand (5,000) tons has been placed in said stockpile, unless the tonnage required on the project is less than five thousand (5,000) tons. The aggregates for the mixture shall be dried and heated to the required temperature. Flames used for drying and heating shall be properly adjusted to avoid damage to the aggregate and to avoid soot on the aggregate.

Immediately after heating and drying, the aggregates shall be screened into three fractions in the case of base or surface aggregates and two fractions in the case of open-graded aggregate, and conveyed into separate compartments ready for batching and mixing with bituminous material.

401.03.09 Mixing. The permissible moisture content of the aggregate at the time of mixing shall not exceed one and one-half (1½) percent. Should the aggregate contain excessive moisture when heated to the temperature required, production shall be reduced until the temperature and moisture requirements are met.

The dried aggregate shall be combined in the mixer in the amount of each fraction of aggregates required to meet the job-mix formula. The bituminous mixture shall be measured or gauged and introduced into the mixer in the amount specified by the job-mix formula.

Commercial filler material, when required, shall be added to the mixer separately and shall be thoroughly dry. If the materials are mixed in a batching plant, the filler material shall be fed directly into the mixer as near the center as possible.

When the aggregates and the bituminous material have

been combined, the entire mass shall be mixed in a pugmill type of mixer. The mixing shall continue for not less than thirty (30) seconds in the batch type plant after the start of introduction of bitumen and as much longer as necessary as determined by the Engineer, to complete mixing. For continuous mixing plants, the output of the pugmill in pounds per second shall not be greater than the dead weight capacity of the pugmill in pounds divided by thirty (30). The size of batch for any pugmill shall not exceed the manufacturer's capacity rating.

Should the mixture, at the plant or in place, show an excess or deficiency of bitumen, show injury or damage due to burning or overheating, or show an improper combination of aggregates, due to the Contractor's failure to conform to specification requirements, it shall be rejected and if still in the truck shall be disposed of as directed. If an unsatisfactory mix, as referred to above, has been placed, it shall be disposed of and replaced as directed. No compensation will be allowed for rejected material.

401.03.10 Spreading and Finishing. The mixture shall be laid upon an approved surface, spread and struck off to grade, and elevation established. Bituminous pavers shall be used to distribute the mixture either over the entire width or over such partial width as may be practicable.

The forward rate of travel of the paving machine(s) shall be regulated to a speed dependent upon the capacity of the mixing plant to furnish the mixture. The machine(s) shall move at a uniform rate with a minimum amount of stopping.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture shall be spread, raked and luted by hand tools. For such areas, the mixture shall be dumped, spread, and screeded to give the required compacted thickness.

The Contractor may windrow plantmixed bituminous base or surface material in front of the spreading and finishing machine, provided that the following conditions and requirements are strictly adhered to:

(a) The windrow is properly sized, thereby insuring the delivery of the correct amount of material to the spreading and finishing machine at all times.

(b) The bituminous mixture shall be transferred from the windrow to the spreading and finishing machine in such a manner that the materials in the spreading machine will be a uniform mixture. The base, upon which the windrow was formed shall not be disturbed and there shall be no excess paving material remaining on this base between the pickup device and the spreading and finishing machine.

(c) The minimum temperature requirements pertain to the material in the hopper of the spreading and finishing machine. Plantmix bituminous mixture that does not meet the minimum temperature specified shall not be incorporated in the work but shall be wasted in a manner satisfactory to the Engineer.

The provisions that plantmix bituminous mixture may be windrowed in advance of the spreading and finishing machine does not pertain to plantmix bituminous open grade. Should any course of bituminous mixture placed by utilizing a windrow be inferior, as determined by the Engineer, to that placed by transferring the bituminous mixture directly from the hauling vehicle to the spreading machine, the use of a windrow shall be discontinued.

401.03.11 Rolling. Rolling patterns shall be as directed by the Engineer. The initial or breakdown rolling shall consist of one complete coverage of the bituminous mixture. Initial rolling shall commence at the lower edge and shall progress toward the highest portion of the roadbed. Under no circumstances shall the center be rolled first. The initial or breakdown rolling shall be followed by three complete coverages with a pneumatic-tired roller while the temperature of the mixture is at or above one hundred forty (140) degrees Fahrenheit. The final rolling of the bituminous mixture shall be performed with a two-axle tandem roller. The sequence of rolling may be modified to provide breakdown rolling with a two-axle tandem or pneumatic-tired roller and final rolling with a three-axle

when directed. Rolling shall be performed in such a manner that cracking, shoving, or displacement will be avoided. All rollers shall be in good condition, and the reversing mechanism so maintained that the roller is capable of changing directions smoothly. The roller shall be kept in continuous motion while rolling so that all parts of the pavement shall receive equal compression. The motion of the roller shall be slow enough at all times to avoid displacement of the pavement. Any displacement occuring as a result of reversing the direction of the roller, or from any other cause, shall be corrected immediately by the use of rakes and fresh mixture when required. To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened.

401.03.12 Joints. Placing of the bituminous paving shall be as continuous as possible. Rollers shall not pass over the unprotected end of a freshly laid mixture unless authorized by the Engineer. Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the course. A brush coat of asphaltic emulsion shall be used on contact surface of transverse joints just before additional mixture is placed against the previously rolled material.

Longitudinal joints shall be spaced in such a manner that joints in succeeding courses will be at least six (6) inches horizontally from joints in any preceding course.

Attention is directed to subsection 401.03.10, "Spreading and Finishing."

401.03.13 Surface Tolerances. Surface tolerances will be specified under the respective sections of bituminous pavement.

401.03.14 Surfacing Miscellaneous Areas. Surfacing of road approaches and connections, street intersection areas, frontage roads, median strip areas, island areas, sidewalks, dikes, gutters, gutter flares, ditches, downdrains, spillways, aprons at the ends of drainage structures, and other designated areas outside the traveled way shall conform to the provisions specified in these specifications.

The combined aggregate grading for bituminous mixtures placed on miscellaneous areas shall conform to that specified for the bituminous mixture placed on the traveled way. The amount of bituminous material used in the bituminous mixture placed in dikes, gutters, gutter flares, downdrains, spillways, aprons at the ends of drainage structures, and other designated areas outside the traveled way shall be increased not less than one (1) percent by weight of the aggregate over the amount of bituminous material used in the bituminous mixture placed on the traveled way. Submittal of a revised job-mix formula will not be necessary.

The bituminous mixture placed in median strip areas, island areas, sidewalks, dikes, gutters, gutter flares, ditches, downdrains, spillways, aprons at the ends of drainage structures, and other designated areas outside the traveled way may be spread in one layer. The material shall be compacted to the required lines, grades, and cross section.

Dikes shall be shaped and compacted with an extrusion machine or other equipment capable of shaping and compacting the material to the required cross section.

METHOD OF MEASUREMENT

401.04.01 Measurement. The quantity of plantmix bituminous aggregate to be measured for payment will be the number of tons conforming to all the requirements in the completed work, and will be determined by weighing the completed mixture of aggregate, mineral filler if required, and bituminous material, and deducting from this weight the weight of the mineral filler and bituminous material.

The quantity of bituminous material to be measured for payment will be the number of tons used in the completed work and shall conform to the requirements herein.

The quantity of shoulder dikes constructed of bituminous mixture, the placing of which is to be paid for as a contract item on a linear foot basis, will be determined from measurements taken along the top of the completed dikes to the nearest one (1) foot length. The quantities of

bituminous mixture used to construct the dikes shall be measured as set forth above.

The quantities of bituminous mixture, the placing of which is to be paid for as a contract item on an area basis in addition to the contract prices paid for the bituminous mixture will be determined from measurements of the bituminous mixture compacted in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities." Batch weights will not be permitted as a method of measurement unless the alternate provisions of subsection 401.03.01 (a)1, "Plant Scales" are met, in which case the cumulative weight of all the acceptable batches will be used for payment.

Due to possible variations in the specific gravity and voids of the aggregate, the tonnage used may vary from the proposal quantities and no adjustment in contract unit price will be made because of such variation.

BASIS OF PAYMENT

401.05.01 Payment. All accepted work and materials measured as prescribed above will be paid for as provided in the respective sections for each type specified.

Full compensation for furnishing and applying bituminous material or asphaltic emulsion as provided for in subsections 401.03.06, "Preparation of Existing Surface" and 401.03.12, "Joints," shall be considered as included in the contract price paid for the principal items involved and no further compensation will be allowed therefor.

SECTION 402

PLANTMIX BITUMINOUS SURFACE

DESCRIPTION

402.01.01 General. This work shall consist of constructing one or more courses of bituminous pavement on a prepared base in accordance with these specifications, and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer.

The requirements of Section 401, "Plantmix Bituminous Pavements—General" shall be applicable to this work, except as hereinafter specified.

MATERIALS

402.02.01 General. The materials shall conform to the requirements as specified in subsection 401.02.01 through 401.02.04, inclusive, of Section 401, "Plantmix Bituminous Pavements—General."

CONSTRUCTION

402.03.01 General. The construction requirements shall conform to the requirements as specified in subsections 401.03.01 through 401.03.14, inclusive, of Section 401, "Plantmix Bituminous Pavements—General," with the exceptions contained in the following three subsections.

402.03.02 Rollers. There shall be operating with each paver, three rollers meeting the requirements of (a), (b), and (c) in subsection 401.03.04, "Rollers," except as hereinafter noted.

When two (2) pavers are paving in echelon within four hundred (400) feet of each other and each paver is placing not more than one hundred fifty (150) tons of bituminous mixture per hour, then three (3) rollers meeting the requirements of (a), (b), and (c) in subsection 401.03.04, "Rollers" may be used to roll for both pavers.

402.03.03 Spreading and Finishing. Unless otherwise specified, bituminous plantmix surface shall be placed in courses not exceeding three (3) inches in compacted thickness. When more than one course is placed, the courses shall be of approximately equal thickness.

Bituminous plantmix surface to be placed on shoulders and other areas off the traveled way having a width of eight (8) feet or more, shall be spread as specified in subsection 401.03.10, "Spreading and Finishing." When the areas are less than eight (8) feet in width the material may be deposited and spread in one or more layers by other mechanical means that will provide a uniform smoothness and texture. Placing bituminous mixture on any pavement that would be stained thereby will not be permitted.

402.03.04 Surface Tolerances. The completed surfacing shall be thoroughly compacted, smooth and free from ruts, humps, depressions, or irregularities. When a straightedge twelve (12) feet long is laid on the finished surface and parallel with the centerline of the highway, the surface shall not vary more than 0.02 foot from the lower edge of the straightedge. The transverse slope of the finished surface shall be uniform to a degree such that no depressions greater than 0.02 foot are present when tested with a straightedge twelve (12) feet long laid in a direction transverse to the centerline and extending from edge to edge of a twelve (12) foot traffic lane.

Any ridges, indentations, or other objectionable marks left in the surface of the bituminous mixture by blading or other equipment shall be eliminated by rolling or other means. The use of any equipment that leaves ridges, indentations, or other objectionable marks in the bituminous mixture shall be discontinued and other acceptable equipment shall be furnished by the Contractor.

METHOD OF MEASUREMENT

402.04.01 Measurement. Plantmix bituminous surface aggregate will be measured as specified in subsection 401.04.01, "Measurement."

BASIS OF PAYMENT

402.05.01 Payment. The accepted quantity of materials measured as provided in subsection 402.04.01, "Measurement" will be paid for at the contract unit price bid per ton for plantmix bituminous surface aggregate, per ton for mineral filler (type) and per ton for bituminous material (Asphalt Cement or Liquid Asphalt).

The above prices shall be full compensation for furnishing all the material, mixing, loading, hauling, placing, compacting, and incidentals necessary for doing all the work involved in constructing plantmix bituminous surface as shown on the plans or established by the Engineer.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Partial payments for plantmix bituminous surface aggregate may be made as set forth under subsection 109.06, "Partial Payments."

Payment will be made under:

Pay Item	Pay Unit
Plantmix Bituminous Surface Aggregate (type .....)	Ton
Mineral Filler (type)	Ton
Asphalt Cement (grade)	Ton
Liquid Asphalt (grade)	Ton
Plantmixing Miscellaneous Areas (type)	Square Yard
Plantmix Bituminous Shoulder Dikes	Linear Foot

SECTION 403

PLANTMIX BITUMINOUS OPEN-GRADED SURFACE

DESCRIPTION

403.01.01 General. This work shall consist of placing plantmix bituminous open-graded surface in one course for surface in accordance with these specifications and in reasonably close conformity with the lines, grades, thickness, and the typical cross sections shown on the plans or established by the Engineer.

The requirements of Section 401, "Plantmix Bituminous Pavements—General," shall be applicable to this work, except as hereinafter specified.

MATERIALS

403.02.01 General. The materials shall conform to the requirements as specified in subsections 401.02.01 through 401.02.04, inclusive, of Section 401, "Plantmix Bituminous Pavements—General."

CONSTRUCTION

403.03.01 General. The construction requirements shall conform to the requirements as specified in subsections 401.03.01 through 401.03.13, inclusive, of Section 401, "Plantmix Bituminous Pavements—General," with the exceptions contained in the following three subsections.

403.03.02 Rollers. There shall be operating with each paver one (1) tandem roller weighing not less than eight (8) nor more than ten (10) tons. When two (2) pavers are paving in echelon, within four hundred (400) feet of each other, then one roller may be used for both pavers.

403.03.03 Joints. Longitudinal joints shall be constructed only on the shoulders, or at the edge of travel lanes.

403.03.04 Surface Tolerances. The completed surfacing shall be thoroughly compacted, smooth and free from ruts, humps, depressions, or irregularities. When a straightedge twelve (12) feet long is laid on the finished surface and parallel with the centerline of the highway, the surface shall not vary more than 0.02 foot from the lower edge of the straightedge. The transverse slope of the finished surface shall be uniform to a degree such that no depressions greater than 0.02 foot are present when tested with a straightedge twelve (12) feet long laid in a direction transverse to the centerline and extending from edge to edge of a twelve (12) foot traffic lane.

Any ridges, indentations, or other objectionable marks left in the surface of the bituminous mixture by blading or other equipment shall be eliminated by rolling or other means. The use of any equipment that leaves ridges, indentations, or other objectionable marks in the bituminous mixture shall be discontinued and other acceptable equipment shall be furnished by the Contractor.

METHOD OF MEASUREMENT

403.04.01 Measurement. Plantmix bituminous open-graded surface aggregate will be measured as specified in subsection 401.04.01, "Measurement."

BASIS OF PAYMENT

403.05.01 Payment. The accepted quantity of materials measured as provided in subsection 403.04.01, "Measurement," will be paid for at the contract unit price bid per ton for plantmix bituminous open-graded surface aggregate and per ton for bituminous material (Asphalt Cement).

The above prices shall be full compensation for furnishing all the materials, mixing, loading, hauling, placing, compacting, and incidentals necessary for doing all the work involved in constructing plantmix bituminous open-graded surface as shown on the plans or established by the Engineer.

All payments will be made in accordance with subsection 109.01, "Scope of Payment."

Partial payments for plantmix bituminous open-graded surface aggregate may be made as set forth under subsection 109.06, "Partial Payments."

Payment will be made under:

Pay Item	Pay Unit
Plantmix Bituminous Open-Graded Surface Aggregate	Ton
Asphalt Cement	Ton

SECTION 404

ROADMIX BITUMINOUS SURFACE

DESCRIPTION

404.01.01 General. This work shall consist of constructing one or more courses of roadmix bituminous pavement on a prepared base or road surface in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer.

The mineral aggregate and bituminus material may be mixed in place in the prepared roadbed, or mixed off of the roadbed by either roadmix or plantmix methods.

MATERIALS

404.02.01 Aggregates. Aggregates shall meet the requirements of Section 705, "Aggregates for Bituminous Courses," for the grading size and type specified. The aggregate will be accepted immediately preceding addition of bituminous material to the mix. This acceptance will be based on periodic samples of the windrow after all aggregates have been blended for each layer. When plantmix method is used, aggregates will be tested for acceptance at the bins. Attention is directed to subsection 106.04, "Samples and Tests."

When the mineral aggregate consists of material in place on the roadbed, which was not placed under the contract providing for the placing of the roadmixed surfacing, all rock or lumps of materials larger in greatest dimension than the planned surface thickness shall be removed and disposed of along the roadway and such work shall be paid for as extra work as provided in subsection 104.03, "Extra Work."

404.02.02 Bituminous Material. The type and grade of bituminous material will be specified in the contract. The grade may be changed one step by the Engineer during construction at no change in unit price.

The bituminous material shall meet the applicable requirements of Section 703, "Bituminous Materials."

Bituminous material may be conditionally accepted at the source.

CONSTRUCTION

404.03.01 Motor Graders. Motor graders for spreading, shaping, and finishing mixture shall be of the self-powered type with blades not less than twelve (12) feet long and wheel bases of not less than seventeen (17) feet.

404.03.02 Distributors. The distributor shall be so designed, equipped, maintained, and operated that bituminous material at even heat may be applied uniformly on variable widths of surface up to fourteen (14) feet at readily determined and controlled rates from 0.05 to 2.0 gallons per square yard, with uniform pressure, and with an allowable variation from any specified rate not to exceed 0.02 gallon per square yard. Distributor equipment shall include a tachometer, pressure gauges, accurate volume measuring devices or a calibrated tank, and a thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump, and full circulation spray bars adjustable laterally and vertically.

404.03.03 Mixing Plants. Traveling or stationary mixing plants or other equipment of proven performance may be used by the Contractor in lieu of the specified equipment if approved. Traveling mixing plant shall have positive controls for applying asphalt.

404.03.04 Rollers. Rollers used shall conform to the requirements of subsection 401.03.04, "Rollers."

404.03.05 Weather Limitations. The mixing, spreading, and compacting of roadmix bituminous pavement shall be carried on only when the surface on which the material is to be placed is dry and when the atmospheric temperature is above fifty (50) degrees Fahrenheit, and has not been below forty (40) degrees Fahrenheit during the preceding twenty-four (24) hours.

404.03.06 Preparation of Existing Surface. Before spreading materials for roadmixing, the surface of the base or road surface on which the roadmix is to be placed shall be conditioned as specified in subsection 401.03.06, "Preparation of Existing Surface."

After a prime coat is applied, it shall be left undisturbed not less than twenty-four (24) hours. The Contractor shall maintain the primed surface until the roadmix material has been placed. This maintenance shall include the spreading of sand or other material, if necessary to prevent adherence of the prime coat to the tires of vehicles using the primed surface, and patching any breaks in the primed surface with additional bituminous material. Any area of primed surface that has become damaged shall be repaired before the roadmix material is placed.

404.03.07 Placing Aggregates. Mineral aggregate shall be deposited upon the prepared subgrade, or mixing area, by the use of spreader boxes, or from the vehicles equipped or supplemented with suitable spreading devices.

The mineral aggregate shall contain sufficient material to construct the roadmix surfacing as planned, including sufficient material for surfacing special features off the traveled way. The aggregate shall not be mixed with earth or other deleterious matter.

If the surface moisture of the aggregate is more than two (2) percent of the dry weight of the aggregate, except when the bituminous material is emulsified asphalt, the aggregate shall be turned by blades or disc harrows or otherwise aerated until the moisture content is reduced to two (2) percent or less. The aggregate shall then be spread smoothly and uniformly over half the road or other convenient width of the surface ready for the application of bituminous material, except that when a traveling mixing plant is used the aggregate shall be formed into a uniform cross section.

In lieu of aerating and drying the aggregate, the Contractor may use an approved additive. The additive shall permit suitable coating of the wet aggregate and shall prevent the bituminous coating from stripping in the presence of water.

404.03.08 Application of Bituminous Material. The bituminous material shall be uniformly distributed in successive application, in such amounts and at such intervals as directed. The temperature of the bituminous material shall conform to the applicable requirements of subsection 406.03.04 of Section 406, "Prime Coat." The mixing equipment shall follow immediately behind the distributor after each application of bituminous material to partially mix the aggregate and the bituminous material. No more bituminous material shall be applied per day than can be mixed with the aggregate on the same day it is applied.

404.03.09 Mixing. The materials may be mixed upon the roadbed, or upon some other approved area off the roadbed by roadmixing methods, or the material may be mixed at a central mixing plant by plantmix methods as specified below, whichever the Contractor elects.

(a) Roadmixing Methods. Prior to applying the bituminous material the prepared aggregate shall be spread smoothly and uniformly over one-half the mixing area or some other convenient width. The first application of bituminous material shall then be applied and partially mixed with the aggregate. The remaining applications of bituminous material with a partial mixing after each application shall follow in like manner. After the last application of bituminous material and partial mixing, the entire mass of bituminous material and aggregate shall be windrowed on the mixing surface and then thoroughly mixed and combined by the mixing units specified, by blading the mix from side to side of the mixing surface, or by a manipulation producing equivalent results, until all particles are coated with bituminous material and the whole mass has uniform color and the mixture is free from spots containing an excess or deficiency of bituminous material, balls, or uncoated particles. During the mixing operations, care shall be taken to avoid cutting into the underlying course or contaminating the mixture with earth or other extraneous matter. When so directed by the Engineer, the mixing process shall be confined to part of the width or area of the roadbed so as to allow a convenient passage for traffic.

Prior to spreading and compacting, should the mixture show an excess or deficiency of bituminous material, or an uneven distribution thereof, the condition shall be corrected by adding mineral aggregate or bituminous material, as the case may be, and then remixing to produce a satisfactory mixture. If necessary, all compressed masses of mixed materials shall be broken up.

When the mineral aggregate consists of the existing material on the roadbed and an allowance for additional mineral aggregate has not been provided for on the plans, additional mineral aggregate may be obtained by scarifying material from the roadbed as directed by the Engineer or, in lieu thereof, the Contractor may import suitable material. No additional compensation will be allowed for conforming to the above requirements, except that additional materials imported and added to that in place will be paid for as extra work as provided in subsection 104.03, "Extra Work."

The amount of material mixed in any one day shall not be more than can be spread and compacted on the following day, provided, however, that when directed by the Engineer, mixed material may remain in the windrow for a longer period.

In lieu of mixing the material as above specified, a roadmixing machine or any equipment other than that required above may be employed which will produce the completed mixture equal to that which would be produced by the means above specified. The Department reserves the right to order the use of any equipment discontinued which, in the opinion of the Engineer, fails to produce a satisfactory mixture.

The roadmixing machine shall be of the pugmill or auger type which picks up the loose material from the mixing area or it may be of the type which cuts a true plane in material at a specified depth, leaving no loose material in either case. Either type shall introduce the bituminous material through a metering device at the time of mixing. The machine shall be equipped to provide for a positive control of the amount of bituminous material introduced into the mix, which can be readily adjusted to the changes required.

The rate of movement of the roadmixing machine, the amount of the material mixed and the amount of mixing shall be so regulated that a mix satisfactory to the Engineer will result. The materials shall be mixed until a uniform mixture of unchanging appearance is obtained and all particles of aggregate are thoroughly coated with bituminous materials. Before mixing, the loose materials shall be placed in windrows or in a blanket of uniform cross section and of such size that all the material in the windrow or blanket can be passed through the mixing machine at each mixing operation.

Materials mixed off the roadbed shall be uniform in character and equal in all respects to that which would be produced by mixing on the roadbed as above specified.

(b) Plantmixing Method. Should the Contractor elect to mix the materials at a central mixing plant by the plant-mix method, the mineral aggregate shall be dried, proportioned, and mixed with the bituminous material in accordance with the applicable requirements of Section 401 of these specifications with the following modifications: When the moisture content of the mineral aggregate does not exceed two (2) percent by weight of the dry aggregate and laboratory tests indicate that such increased moisture content will not produce an unstable mixture, mixing of the materials without passing the aggregate through a dryer will be permitted.

Unless otherwise specified in the special provisions, separation of the mineral aggregate into required sizes and storing in separate bins will not be required.

404.03.10 Spreading, Compacting, and Finishing. Before the finished mixture is spread for compaction, a triangular cut shall be made with a motor grader at each edge of the base course to provide for a thickened edge of bituminous mixture. The cut shall be approximately two (2) inches deep at the outer edge and slope to zero, two (2) feet in toward the center. In making a cut the excavated material shall be thrown to the edge of the roadbed in a small windrow against which the mixture shall then be spread.

After roadmixing operations have been completed and the mixture has been approved by the Engineer, the mixture shall be uniformly spread over the area to be surfaced to the proper width and to such depth as will compact to the required thickness. The mixture shall be spread by means of a motor grader meeting the requirements of subsection 404.03.01, "Motor Graders."

Segregation of coarse or fine particles shall be avoided and the mixture shall be free from lumps or pockets of coarse and fine material after spreading.

After the mixture has been spread as above specified, approximately the top half of the material shall be removed by motor graders and placed into a windrow on one side. The windrow shall be so placed that earth or other extraneous materials will not become intermixed with the windrowed material. The exposed area not occupied by the windrow shall then be thoroughly rolled. Rolling shall be continuous throughout the spreading operations. The windrowed material shall then be respread over the entire surface by alternating the windrow from one side of the roadbed to the other and to the center and gradually decreasing the amount of material moved, until the entire surface has uniform texture and is smooth and true to cross section and grade and is uniformly compacted. During blading and rolling, all lumps and loose stones shall be moved to the outside of the surface area and disposed of.

All rolling, except the final finish rolling, shall be done with pneumatic-tired rollers. The finish rolling shall be done with steel-tired tandem or three-wheeled rollers commencing at the lower edge, progressing toward the highest portion. Under no circumstances shall the highest portion be rolled first.

404.03.11 Miscellaneous Areas. Surfacing of road approaches and connections, street intersection areas, frontage roads, median strip areas, island areas, sidewalks, dikes, gutters, gutter flares, ditches, overside drains, spillways, aprons at the ends of drainage structures, and other designated areas outside the traveled way shall conform to the provisions specified in these specifications.

The combined aggregate grading for bituminous mixtures placed on miscellaneous areas shall conform to that specified for the bituminous mixture placed on the traveled way. The amount of bituminous material used in the bituminous mixture placed in dikes, gutters, gutter flares, overside drains, spillways, aprons at the ends of drainage structures, and other designated areas outside the traveled way shall be increased not less than one percent by weight of the aggregate over the amount of bituminous material used in the bituminous mixture placed on the traveled way.

404.03.12 Surface Tolerances. The surface will be tested by the Engineer using a twelve (12) foot straightedge at selected locations. The variation of the surface from the testing edge of the straightedge between any two contacts with the surface shall at no point exceed 0.03 foot. All humps or depressions exceeding the specified tolerance shall be corrected by removing defective work and replacing it with new material as specified.

METHOD OF MEASUREMENT

404.04.01 Measurement. The quantity of roadmix bituminous surface aggregate to be measured for payment will be the number of tons or cubic yards as indicated in the proposal, conforming to all the requirements in the completed work. When the mixture is mixed at a central mixing plant by the plantmix method, the number of tons will be determined by weighing the completed mixture of aggregate and bituminous material and deducting from this weight the weight of the bituminous material.

Mineral aggregate consisting of material in place on the roadbed will not be measured and paid for, except for the removal of rocks and lumps as provided in subsection 404.02.01, "Aggregates" of this section. All other work involved in scarifying and preparing the material as herein specified shall be considered as included in the contract unit price paid for mixing the roadmix surfacing.

Mixing and compacting shall be measured in miles along the centerline of the roadway and no extra allowance will be made for mixing widened sections and shoulder dikes, unless otherwise provided in the special provisions.

The quantity of shoulder dikes constructed of bituminous mixture, the placing of which is to be paid for as a contract item on a linear foot basis, will be determined from measurements taken along the top of the completed dikes to the nearest one (1) foot length. The quantities of bituminous mixture used to construct the dikes shall be measured as set forth above.

The quantities of bituminous mixture, the placing of which is to be paid for as a contract item on an area basis in addition to the contract prices paid for the bituminous mixture will be determined from measurements of the bituminous mixture compacted in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities." Batch weights will not be permitted as a method of measurement unless the alternate provisions of subsection 401.03.01(a)1, "Plant Scales" are met, in which case the cumulative weight of all the acceptable batches will be used for payment.

Tonnage shall conform reasonably close to that shown on the plans, unless otherwise directed. Due to possible variations in the specific gravity and voids of the aggregates, the thickness may vary from that shown on the plans.

BASIS OF PAYMENT

404.05.01 Payment. The accepted quantity of materials measured as provided in subsection 404.04.01, "Measurement," will be paid for at the contract unit price bid per ton or cubic yard for roadmix bituminous surface aggregate, per ton for bituminous material (Liquid Asphalt) and per mile for mixing the roadmix bituminous pavement.

The above prices shall be full compensation for furnishing all the material, mixing, loading, hauling, placing, compacting, and incidentals necessary for doing all the work involved in constructing roadmix bituminous surface, as shown on the plans or established by the Engineer.

Full compensation for furnishing and applying bituminous material or asphaltic emulsion as provided for in subsection 404.03.06, "Preparation of Existing Surface"

shall be considered as included in the contract price paid for the principal items involved and no further compensation will be allowed therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Partial payments for roadmix bituminous surface aggregate may be made in accordance with subsection 109.06, "Partial Payments."

Payment will be made under:

Pay Item	Pay Unit
Roadmix Bituminous Surface Aggregate	Ton or Cubic Yard
Liquid Asphalt (grade)	Ton
Mixing Roadmix Bituminous Surface (width)	Mile
Roadmixing Miscellaneous Areas (type)	Square Yard
Roadmix Bituminous Shoulder Dikes	Linear Foot

SECTION 405

TACK COAT

DESCRIPTION

405.01.01 General. This work shall consist of preparing and treating an existing bituminus or concrete surface with bituminous material in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or established by the Engineer.

MATERIALS

405.02.01 Bituminous Material. The type and grade of bituminous material will be specified in the contract. The grade may be changed one step by the Engineer during construction at no change in unit price.

The bituminous material shall meet the applicable requirements of Section 703, "Bituminous Materials." The bituminous material may be conditionally accepted at the source.

Asphaltic emulsion used as a Tack Coat between the courses of plantmix surface or over an existing surface shall be of the type and grade specified and prepared for application as follows:

The emulsion shall be cut back by water. Water shall be added in the quantity of forty (40) percent of the emulsion by weight. To accomplish this mixing, the distributor shall be partly filled with water, and the correct proportion of emulsified asphalt shall then be added, and the remaining water to be added shall be sprayed into the tank under pressure and then thoroughly circulated within the distributor.

CONSTRUCTION

405.03.01 Equipment. The Contractor shall provide equipment for heating and applying the bituminous material. This equipment shall meet the requirements of subsection 404.03.02, "Distributors."

405.03.02 Weather Limitations. Application of bituminous material will not be permitted when the surface to

be treated is damp or wet or when weather conditions are unsuitable or when the atmospheric temperature or aggregate temperature is below forty (40) degrees Fahrenheit.

405.03.03 Preparation of Surface. The existing surface shall be patched and cleaned and be free of irregularities to provide a reasonably smooth and uniform surface to receive the treatment. The edges of existing pavements, which are to be adjacent to new pavement, shall be cleaned to permit the adhesion of bituminous materials.

Where the Contractor is applying tack upon a previously constructed course under the contract, payment for patching cleaning, repairing, etc., will be made at the Contractor's expense, unless otherwise provided. Attention is directed to subsection 104.04, "Maintenance of Traffic" and subsection 105.14, "Maintenance During Construction."

Where the Contractor is applying tack upon a previously constructed course not a part of the contract, and when there are no items or provisions to pay for preparing the existing surface, the Contractor shall be paid for such preparation under the provisions of subsection 104.03, "Extra Work."

405.03.04 Application of Bituminous Materials. The bituminous material shall be uniformly applied at the rate called for on the plans or ordered by the Engineer. When asphaltic emulsion is used, the temperature at the time of application shall be between one hundred (100) degrees Fahrenheit and one hundred fifty (150) degrees Fahrenheit unless otherwise ordered by the Engineer. When liquid asphalt is used, the temperature at the time of application shall conform to the applicable requirements in Table I of subsection 406.03.04 of Section 406, "Prime Coat."

The tack coat shall be applied in such manner as to offer the least inconvenience to traffic and to permit one-way traffic without pickup or tracking of the bituminous material. Tack coat shall be applied only so far in advance that it will be covered during the following thirty-six (36) hours.

METHOD OF MEASUREMENT

405.04.01 Measurement. The quantity of bituminous material to be measured for payment will be the number of tons conforming to all the requirements in the completed work.

Bituminous material diluted as prescribed shall be measured in tons of the diluted mixture acceptably applied to the surface.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

405.05.01 Payment. The accepted quantity of bituminous material measured as provided in subsection 405.-04.01, "Measurement," will be paid for at the contract unit price bid per ton.

The above prices shall be full compensation for furnishing the material, mixing, loading, hauling, placing, and incidentals necessary for doing all the work involved in placing tack coat, as shown on the plans or established by the Engineer, all in accordance with subsection 109.02, "Scope of Payment."

The Department reserves the right to increase or to omit all or any part of the estimated amount of bituminous material to be used and no additional compensation shall be allowed by reason of such increase or decrease.

Payment will be made under:

Pay Item	Pay Unit
Liquid Asphalt (type)	Ton
Emulsified Asphalt (type)	Ton

SECTION 406

PRIME COAT

DESCRIPTION

406.01.01 General. This work shall consist of preparing and treating an existing surface with bituminous material, and blotter material, if required, in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or established by the Engineer.

MATERIALS

406.02.01 Bituminous Material. The type and grade of bituminous material will be specified in the contract. The grade may be changed one step by the Engineer during construction at no change in unit price.

The bituminous material shall meet the applicable requirements of Section 703, "Bituminous Materials." The bituminous material may be conditionally accepted at the source.

406.02.02 Sand Blotter. Sand blotter shall meet the requirements of subsection 705.03.05, "Sand Blotter." The material may be accepted in stockpile at the source.

CONSTRUCTION

406.03.01 Equipment. The Contractor shall provide equipment for heating and applying the bituminous material and for applying blotter material. The equipment shall meet the requirements of subsection 404.03.02, "Distributors."

406.03.02 Weather Limitations. Bituminous material shall not be applied on a wet surface; when the atmospheric temperature is below fifty (50) degrees Fahrenheit or when weather conditions, in the opinion of the Engineer, would prevent the proper construction of the prime coat.

406.03.03 Preparation of Surface. The surface upon which the bituminous prime coat is to be placed shall conform to the established lines and grades, shall be reasonably smooth and uniform and shall be compacted to the required density. If the required density deteriorates from the time the gravel course was compacted originally and the time the prime coat is placed, for any reason whatsoever, then the surface shall be recompacted to the required density at the expense of the Contractor. When required by the Engineer, an application of water shall be applied immediately before bituminous application.

406.03.04 Application of Bituminous Material. Bituminous material shall be applied to the width of the section to be primed by means of a pressure distributor in a uniform, continuous spread. When traffic is maintained, not more than one-half (½) of the width of the section shall be treated in one application. Care shall be taken that the application of bituminous material at the junctions of spreads is not in excess of the specified amount. Excess bituminous material shall be squeegeed from the surface. Skipped areas or deficiencies shall be corrected.

When traffic is maintained, one-way traffic shall be permitted on the untreated portion of the roadbed. As soon as the bituminous material has been absorbed by the surface and will not pick up, traffic shall be transferred to the treated portion and the remaining width of the section shall be primed.

The bituminous material shall be uniformly applied at the rate called for on the plans or ordered by the Engineer. When asphaltic emulsion is used, the temperature at the time of application shall be between one hundred (100) degrees Fahrenheit and one hundred fifty (150) degrees Fahrenheit. When liquid asphalt is used, the temperatures shall conform to the requirements of the following table:

Loading, Spraying, and Mixing Temperatures for Four-Grade Liquid Asphalt System

All Grades	Loading Temp. ° F.—Maximum*	Spraying Temp. ° F. Min.	Spraying Temp. ° F. Max.	Pugmill Mixing Temp. of Aggregates for MC & SC Liquid Asphalts, ° F. Min.	Pugmill Mixing Temp. of Aggregates for MC & SC Liquid Asphalts, ° F. Max.
70	195	105	175	90	155
250	245	140	225	125	200
800	275	175	255	160	225
3000	310	215	290	200	260

*Line Temperatures

406.03.05 Application of Blotter Material. If, after the application of the prime coat, the bituminous material fails to penetrate within three (3) to six (6) days and the roadway must be used by traffic, blotter material shall be spread in the amounts required to absorb any excess bituminous material. When necessary for traffic, blotter material may be spread prior to three (3) days' penetrating time.

METHOD OF MEASUREMENT

406.04.01 Measurement. The quantity of bituminous material to be measured for payment will be the number of tons conforming to all the requirements in the completed work. The quantity of blotter sand measured for payment will be the number of tons or cubic yards conforming to all the requirements in the completed work.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

406.05.01 Payment. The accepted quantity of materials measured as provided in subsection 406.04.01, "Measurement," will be paid for at the contract unit price bid per ton for bituminous material and per ton or cubic yard for blotter sand.

When sand blotter is not included in the proposal and it is needed to protect the work or public traffic, it shall be furnished and spread as herein described, and payment therefor will be in accordance with subsection 104.03, "Extra Work."

The above prices shall be full compensation for furnishing the material, mixing, loading, hauling, placing, and incidentals necessary for doing all the work involved in placing prime coat and sand blotter, as shown on the plans or established by the Engineer.

The Department reserves the right to increase or to omit all or any part of the estimated amount of blotter material or bituminous material to be used and no additional compensation shall be allowed by reason of such increase or decrease.

Watering will be paid for in accordance with Section 210, "Watering."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Liquid Asphalt (type)	Ton
Emulsified Asphalt (type)	Ton
Sand Blotter	Ton or Cubic Yard

SECTION 407

SEAL COAT

DESCRIPTION

407.01.01 General. This work shall consist of an application of bituminous material on a compacted and bonded bituminous surface, and blotter material, if required, in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or established by the Engineer.

MATERIALS

407.02.01 Bituminous Material. The type and grade of bituminous material will be specified in the contract. The grade may be changed one step by the Engineer during construction at no change in unit price.

The bituminous material shall meet the applicable requirements of Section 703, "Bituminous Materials." The bituminous material may be conditionally accepted at the source.

407.02.02 Sand Blotter. Sand blotter shall meet the requirements of subsection 705.03.05, "Sand Blotter." The material may be accepted in stockpile at the source.

CONSTRUCTION

407.03.01 Equipment. The Contractor shall provide equipment for heating and applying the bituminous material and for applying blotter material. The equipment shall meet the requirements of subsection 404.03.02, "Distributors."

407.03.02 Weather Limitations. Bituminous material shall not be applied on a wet surface, when the temperature is below fifty (50) degrees Fahrenheit or when weather conditions, in the opinion of the Engineer, would prevent the proper construction of the seal coat.

407.03.03 Preparation of Surface. Immediately before applying the bituminous material the surface to be sealed shall be thoroughly cleaned of all dirt and loose material by sweeping with power brooms supplemented by hand brooms if necessary. The process of cleaning shall continue until dirt and loose material is removed from the entire width of the surfacing.

407.03.04 Application of Bituminous Material. Bituminous material shall not be spread later in the day than will permit the stopping of traffic control prior to darkness. Bituminous material shall be applied to only one designated traffic lane at a time and the entire width of the lane shall be covered in one operation.

The bituminous material shall be uniformly applied at the rate called for on the plans or ordered by the Engineer. The temperature of the bituminous material shall conform to the applicable requirements of subsection 406.03.04, of Section 406, "Prime Coat."

The seal coat shall be applied in such manner as to offer the least inconvenience to traffic and to permit one-way traffic without pickup or tracking of the bituminous material.

When a surface treatment is to be applied to the central portion of the pavement, the seal coat shall be applied to the shoulder at least four (4) days in advance of the application of the adjacent surface treatment requiring screenings, and the seal coats shall be applied in such a manner that the joint between the two types will present a neat and uniform appearance true to the line shown on the typical cross section and as established by the Engineer.

407.03.05 Application of Blotter Material. The applicable requirements of Section 406, "Prime Coat," shall apply to this Section 407, "Seal Coat," when sand blotter is required.

METHOD OF MEASUREMENT

407.04.01 Measurement. The quantity of bituminous material to be measured for payment will be the

number of tons conforming to all the requirements in the completed work.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

407.05.01 Payment. The accepted quantity of materials measured as provided in subsection 407.04.01, "Measurement," will be paid for at the contract unit price bid per ton for bituminous material.

The above price shall be full compensation for furnishing the material, mixing, loading, hauling, placing, and incidentals necessary for doing all the work involved in placing seal coat as shown on the plans or established by the Engineer.

The Department reserves the right to increase or to omit all or any part of the estimated amount of bituminous material to be used and no additional compensation shall be allowed by reason of such increase or decrease.

Sand blotter will be paid for in accordance with Section 406, "Prime Coat."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Liquid Asphalt (type)	Ton
Emulsified Asphalt (type)	Ton

SECTION 408

SURFACE TREATMENT

DESCRIPTION

408.01.01 General. This work shall consist of an application of bituminous material and cover of screenings applied on a previously compacted and bonded bituminous surface, all in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or established by the Engineer.

MATERIALS

408.02.01 Bituminous Material. The type and grade of bituminous material will be specified in the contract. The grade may be changed one step by the Engineer during construction at no change in unit price.

The bituminous material shall meet the applicable requirements of Section 703, "Bituminous Materials." The bituminous material may be conditionally accepted at the source.

408.02.02 Screenings. Screenings shall meet the requirements of subsection 705.03.04, "Screenings" for the size specified. Attention is directed to subsection 106.04, "Samples and Tests."

CONSTRUCTION

408.03.01 Distributors. The distributor shall meet the requirements of subsection 404.03.02, "Distributors."

408.03.02 Aggregate Spreader. The aggregate spreader shall be self propelled and supported by at least four (4) wheels equipped with pneumatic tires on two axles. The aggregate spreader shall be equipped with positive control so that the required amount of material will be deposited uniformly over the full width of the bituminous material.

408.03.03 Rollers. There shall be operating with each aggregate spreader, one pneumatic-tired roller and

one steel-wheel roller. The pneumatic-tired roller shall meet the requirements of subsection 401.03.04, "Rollers" (b). The steel-wheel roller shall meet the requirements of the same subsection, (a) or (c).

408.03.04 Weather Limitations. Bituminous material shall not be spread when weather conditions are unsuitable, or when the atmospheric temperature is below sixty-five (65) degrees Fahrenheit or the pavement temperature is below eighty (80) degrees Fahrenheit.

408.03.05 Maintaining Traffic. Where public traffic is being routed over a surface upon which a surface treatment is to be applied, the surface treatment shall not be applied to more than one-half the width of the traveled way at a time, and the remaining half width shall be kept free of obstructions and open for use by public traffic at all times until the surface treatment first applied is ready for use by traffic.

Traffic will not be allowed on the newly placed bituminous material and screenings until, in the opinion of the Engineer, the screenings and bituminous material have sufficiently set and bonded to prevent displacement by such traffic.

When the newly completed surface treatment is open to traffic, the traffic shall be controlled by use of flagmen and a pilot car for a period of six (6) hours or for such time as deemed necessary by the Engineer as follows:

(a) A flagman shall be stationed at the beginning of each newly completed section open to traffic, to stop oncoming traffic preparatory to piloting operations and shall be kept on duty during the entire control period.

(b) Traffic control as described above shall be moved ahead progressively as the newly completed surface is open to traffic.

408.03.06 Preparation of Surface. Immediately before applying the bituminous material, the surface to be treated shall be thoroughly cleaned of all dirt and loose material by sweeping with power brooms supplemented by hand brooms if necessary. The process of cleaning shall

continue until the surfacing is exposed and all dirt and loose material is removed from the entire width of surfacing.

408.03.07 Application of Bituminous Material. Bituminous material shall be applied by means of a pressure distributor in a uniform, continuous spread over the section to be treated. The temperature of the bituminous material shall conform to the applicable requirements of subsection 406.03.04, of Section 406, "Prime Coat." The quantity of bituminous material to be used per square yard shall be as directed. If the texture of the surface is such that bituminous material penetrates too rapidly, a preliminary application of from 0.05 to 0.10 gallon per square yard of surface may be required. A strip of building paper, at least three (3) feet in width and with a length equal to that of the spray bar of the distributor plus one (1) foot, shall be used at the beginning of each spread. If the cutoff is not positive, the use of paper may be required at the end of each spread. The paper shall be removed and disposed of in a satisfactory manner. The distributor shall be moving forward at proper application speed at the time the spray bar is opened. Any skipped areas or deficiencies shall be corrected. Junctions of spreads shall be carefully made to assure a smooth riding surface.

The length of spread of bituminous material shall not be in excess of that which trucks loaded with screenings can immediately cover.

The spread of bituminous material shall not be more than six (6) inches wider than the width covered by the screenings from the spreading device. Under no circumstances shall operations proceed in such manner that bituminous material will be allowed to chill, set up, dry, or otherwise impair retention of the screenings.

The distributor, when not spreading, shall be parked so that the spray bar or mechanism will not drip bituminous materials on the surface of the traveled way.

408.03.08 Application of Screenings. Immediately following the application of the bituminous material,

screenings shall be spread at the required rate per square yard.

In order to avoid building a longitudinal joint, when spreading screenings on the first width of bituminous material, no screening shall be applied within six (6) inches of the edge adjacent to the next application of bituminous material.

Bituminous material and screenings shall not be spread over a greater distance than can be rolled and finished within one (1) day's operation.

In order to eliminate dust film, screenings shall be moistened with water before being applied. In spreading the screenings, the equipment used shall be so operated that the fresh bituminous material will be covered before equipment wheels come upon it.

Asphaltic emulsion applied to the road surface shall be covered with screenings before setting or breaking occurs.

After the screenings have been spread upon the bituminous material, any piles, ridges, or uneven distribution shall be carefully removed with flat bottom shovels, or other approved methods to insure against permanent ridges or bumps in the completed surface. Additional screenings shall be spread by hand in whatever quantities required to prevent picking up by the rollers or traffic.

After the application of the screenings the surface where specified shall be lightly broomed or otherwise maintained as directed for a period of four (4) days or as directed. Maintenance of the surface shall include the distribution of screenings over the surface to absorb any free bituminous material and cover any area deficient in screenings. The maintenance shall be conducted so as not to displace imbedded material. Excess material shall be swept at the time determined by the Engineer.

408.03.09 Rolling. Rolling shall follow immediately behind spreading screenings to properly embed the screenings in the soft bituminous material and rolling shall commence at the outer edges and proceed toward the inner edge of each spread of bituminous material and

screenings, and shall be continued until the screenings are thoroughly set.

The sequence of rollers and roller patterns will be established by the Engineer.

METHOD OF MEASUREMENT

408.04.01 Measurement. The quantity of bituminous material to be measured for payment will be the number of tons conforming to all the requirements in the completed work. The quantity of screenings measured for payment will be the number of tons or cubic yards conforming to all the requirements in the completed work.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

408.05.01 Payment. The accepted quantity of materials measured as provided in subsection 408.04.01, "Measurement," will be paid for at the contract unit price bid per ton for bituminous material and per ton or cubic yard for screenings.

The above prices shall be full compensation for furnishing the material, mixing, loading, hauling, placing, rolling, sweeping, and incidentals necessary for doing all the work involved in placing bituminous material and screenings, as shown on the plans or established by the Engineer.

The Department reserves the right to increase or to omit all or any part of the estimated amount of screening material or bituminous material to be used and no additional compensation shall be allowed by reason of such increase or decrease.

Flagmen and pilot cars will be paid for in accordance with Section 624, "Accommodations for Public Traffic."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Liquid Asphalt (type)	Ton
Emulsified Asphalt (type)	Ton
Screenings	Ton or Cubic Yard

SECTION 409

PORTLAND CEMENT CONCRETE PAVEMENT

DESCRIPTION

409.01.01 General. This work shall consist of a pavement composed of Portland cement concrete, with or without reinforcement as specified, constructed on a prepared subgrade or base course in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer.

At the option of the Contractor, concrete pavement may be constructed with equipment utilizing stationary side forms or by the use of slip-form paving equipment.

MATERIALS

409.02.01 General. Materials shall conform to the requirements of the following sections and subsections:

Fine Aggregate	Subsection 706.03.03
Course Aggregate	Subsection 706.03.01
Portland Cement	Section 701
Water	Section 722
Air Entraining Admixtures	Subsection 702.03.03
Calcium Chloride	Subsection 702.03.05
Joint Filler	Subsection 707.03.01
Curing Materials	Subsection 702.03.01
Subgrade Paper	Subsection 702.03.02
Reinforcement	Section 713

An inadequate water supply shall be concluded sufficient cause for delaying or stopping mixing operations. In case of a deficiency of water, the requirements for subgrade and curing concrete previously placed shall have priority over mixing.

409.02.02 Gradation Requirements. Gradation requirements shall conform to the requirements as specified in subsection 501.02.02, "Gradation Requirements."

409.02.03 Concrete Properties and Tests. Portland cement concrete pavement shall be subject to the following requirements and test methods:

Test	Test Designation	Requirements
Flexural Strength of Concrete	Nev. T442	Subsection 409.03.13, "Protection of Pavement"
Length of Drilled Cores	Nev. T452	Subsection 409.04.02, "Pavement Thickness"
Proportions of Coarse Aggregate in Fresh Concrete	Nev. T449*	Compliance with uniformity specified in test method
Slump	Nev. T439	Table I
Evaluation of Profiles	Nev. T446	Subsection 409.03.11, "Riding Tolerances"
12 foot Straightedge Tolerances	Nev. T380	0.01 ft. max. longitudinal —0.02 ft. max. transverse
Method of Test for Specific Gravity and Absorption of Coarse Aggregate	Nev. T492	Min. saturated surface dry condition
Method of Test for Specific Gravity and Absorption of Fine Aggregate	Nev. T493	Min. saturated surface dry condition

*Referee Test Method

CONSTRUCTION

409.03.01 Classification and Proportions. The Contractor shall notify the Engineer not less than thirty-two (32) calendar days in advance of use of the proposed sources of materials and shall make arrangements for the Engineer to obtain samples as required for testing purposes.

When requested by the Contractor and allowed in writing by the Engineer, samples will not be required from aggregate sources previously tested within the past one (1) year.

Samples will not exceed five hundred (500) pounds for each separate grading. The Contractor shall furnish a written statement giving the cement factor in sacks per cubic yard, the proportions of cement, water, and each size of aggregate in S.S.D. condition, and the percentage of air in the concrete proposed for use in the work. If the Contractor proposes to use an admixture other than an air-entraining agent, he shall state its complete brand name and the quantity proposed to be used per sack of cement. The Engineer, after making such tests as he deems advisable, will either accept the proposed materials and proportions or suggest modifications needed for acceptance. After acceptance by the Engineer of batch proportions and materials, they shall not be altered during the course of the work except as found necessary to maintain yield, cement factor, and unit weight within specification requirements.

Portland cement concrete shall be proportioned, using the aggregates tested, such that the requirements in Table I will be satisfied without falling below the minimum, or exceeding the maximum values given.

The cement factor of any individual batch placed in the work shall not be more than 0.15 sack per cubic yard less, nor more than 0.25 sack per cubic yard greater than the designated factor (sacks of cement per cubic yard). Aggregates shall be batched and reported to the resident engineer. The weights used may be varied as necessary to comply with the above tolerances in cement factor and unit weight.

Coarse and fine aggregate in each batch of concrete shall be combined in proportions that will produce a mixture within the grading limits for combined aggregates specified as follows:

Grading Limits of Combined Aggregates

Sieve Sizes	Percentage Passing
2″	100
1½″	90–100
1″	50–86
¾″	45–75
⅜″	38–55
No. 4	30–45
No. 8	23–35
No. 16	15–27
No. 30	8–17
No. 50	4–13
No. 100	1–5
No. 200	0–3

409.03.02 Equipment. (a) General. Equipment and tools necessary for handling materials and performing all parts of the work must meet the approval of the Engineer as to design, capacity, and mechanical condition. This equipment shall be on the site, available for inspection, testing, and approval before paving operations are started. All equipment, tools, and machinery shall be maintained in a satisfactory working condition.

The Contractor shall provide equipment of such capacity that the paver will operate continuously or at a constant rate of production insofar as feasible. In the event that any piece of equipment does not have sufficient capacity to keep pace with the other operations, the Engineer may limit the size of the batch or otherwise limit the rate of production to prevent poor workmanship, overloading of equipment, or frequent delays.

Any equipment operating entirely or partially on the pavement, regardless of the age of the pavement, shall be equipped so that only rubber-tired wheels will come in contact with the pavement.

(b) Batch Plant and Equipment. When the size of the batch of concrete aggregates to be mixed exceeds one cubic yard, the Contractor shall install and maintain in operating condition, an electrically actuated moisture meter that will indicate on a readily visible scale, the percentage of moisture in the fine aggregate as it is batched within a sensitivity of one-half (½) percent by weight of the fine aggregate.

TABLE I

Class of Concrete	Sacks Cem. Per Cu. Yd., Min.–Max.	Coarse Agg. Size No.	Max. Water, Gal. Per Sack Cem.*	Slump Range, Inches	Air Range, Percent	Unit Weight Variation
P.C.A.	5.5–7.0	467	5	0–3.0†	4 ± 1	$\pm$ 3 lbs.
P.C.A.A.	6.0–7.5	467	5	0–3.0†	5 ± 1	$\pm$ 3 lbs.

*Based on aggregate in a saturated surface dry condition.

†The nominal slump in inches shall be 3.0—the maximum slump shall be three and one-half (3.5). When the slump of concrete is found to exceed the nominal slump, the mixture shall be adjusted as directed by the Engineer to reduce slump to a value within the nominal range. Four slump tests will be considered sufficient to determine nominal slump. The difference in slump, determined by comparing slump tests on two samples of mixed concrete for each individual batch tested, shall not exceed one (1) inch. When the difference in slump does exceed one (1) inch, procedure and equipment used in producing the concrete shall be adjusted to reduce the difference in slump to not more than one (1) inch.

For all batches with a volume of one cubic yard or more, the batching equipment shall conform to one of the following combinations:

1. Separate boxes and separate dial or beam scales for weighing each size of aggregate.
2. Single box and dial or multiple beam type scales for all aggregates.
3. Single box or separate boxes and automatic weighing mechanism for all aggregates.

In order to check the accuracy of batch weights, the gross weight and tare weight of batch trucks, truck mixers, and truck agitators, shall be determined when ordered by the Engineer. The equipment shall be weighed at the Contractor's expense on scales approved by the Engineer.

Aggregates and bulk cement for use in pavement shall be proportioned by weight by means of automatic proportioning devices of approved type conforming to the requirements specified herein.

Bulk cement shall be weighed on scales separate and distinct from the aggregate hopper or hoppers. The discharge mechanism of the bulk cement hopper shall be interlocked against opening before the full amount of cement is in the hopper, against closing before the contents of the hopper are entirely discharged and the scales are back in balance, and against opening when the amount of cement in the hopper is either over or under weight by more than one (1) percent of the amount specified.

The bulk cement batcher and aggregate batched shall be so interlocked that a new batch of cement cannot be started until all weigh hoppers are empty, the scale at zero, and the discharge gates closed. The interlock shall permit no part of the batch to be discharged until all aggregate hoppers and the cement hopper are charged with the correct weight.

The discharge gate on the cement hopper shall be so designed to permit regulating the flow of cement into the aggregate as approved by the Engineer.

Material discharged from the several bins shall be controlled by gates or by mechanical conveyors. The means of withdrawal from the several bins, and of discharge

from the weigh box, shall be so interlocked that not more than one bin can discharge at a time; that the order of discharge can be changed; and that the weigh box cannot be tripped until the required quantity from each of the several bins has been deposited therein. Should a separate weigh box be used for each size of aggregate, all may be operated and discharged simultaneously.

When the discharge from the several bins is controlled by gates, each gate shall be actuated automatically so that the required weight is discharged into a weigh box, after which the gate shall automatically close and lock.

The automatic weighing device of the dial or multiple beam scale shall be so designed that the number of proportions required may be set on the dial or dial control and beams at the same time, and that proportions and the sequence of weighing individual sizes may be changed without delay.

It is the intention of this specification that the device shall be automatic to the extent that the only manual operation required for proportioning the aggregates and cement for one batch shall be a single operation of a switch or a starter.

(c) Mixers. All mixing equipment shall meet the provisions set forth in subsection 501.03.06, "Machine Mixing."

(d) Finishing Equipment.

1. Finishing Machine. Screeding and tamping shall be performed with two reciprocating screeds between which is mounted a tamping bar actuated at each end by positive displacement devices.

2. Vibrators. The concrete for the full paving width shall be vibrated by means of surface vibrators with internal vibrators adjacent to each longitudinal edge or by some other method of vibration that produces equivalent results without segregation. The rate of vibration shall be not less than 3,500 vibrations per minute for surface vibrators and 5,000 vibrations per minute for internal vibrators. The amplitude of vibration shall be sufficient to be perceptible on the surface of the concrete more than one (1) foot from the vibrating element. The

Contractor shall furnish a tachometer or other suitable device for measuring and indicating the actual frequency of vibrations.

Vibrators shall not rest on new pavements or side forms. Power to the vibrators shall be so connected that vibration will cease when the forward or backward motion of the machine is stopped.

(e) Concrete Saw. The Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing with a water-cooled diamond edge saw blade or an abrasive wheel to the required dimensions and at the required rate. The Contractor shall provide at least one standby saw in good working order. An ample supply of saw blades shall be maintained at the site of the work at all times during sawing operations.

(f) Forms.

1. Side Form. Metal side forms shall be used exclusively and shall weigh, not including stakes, not less than eighteen (18) pounds per linear foot for pavement 0.67 foot thick, not less than twenty (20) pounds per linear foot for pavement 0.75 foot thick, and not less than twenty-two (22) pounds per linear foot for pavement 0.83 foot thick.

For pavement edges more than 0.67 foot thick, the forms used for 0.67 foot pavement may be built-up by rigidly attaching a metal section to either the top or the bottom of the form, or both. The attachment and form shall act as a rigid unit and shall conform to the weight requirements above for the dimension of the built-up unit. The width of the base shall be equal to 0.67 foot or to eighty (80) percent of the specified thickness of the pavement, whichever is the greater.

Side forms shall be of such section and of sufficient rigidity, both in the form and in the interlocking connection with the adjoining forms, that springing will not occur under the weight of the subgrading and paving equipment or from the pressure of the pavement when placed. The Contractor shall provide sufficient forms so that there will be no delay in placing the pavement due to lack of forms.

Side form sections shall be straight, free from warps,

bends, indentations, or other defects. Defective forms shall be removed from the work.

2. Slip Form. Slip-form paving equipment shall be equipped with traveling side forms of sufficient dimensions, shape, and strength to support the concrete laterally for a sufficient length of time during placement to produce pavement of the required cross section.

No abrupt changes in longitudinal alignment of the pavement will be permitted. The horizontal deviation shall not exceed 0.10 foot from the alignment established by the Engineer.

409.03.03 Preparation of Grade. Unless otherwise provided in the contract documents, concrete pavement shall be placed on a cement treated base conforming to the provisions of Section 305, "Portland Cement Treated Base."

The subgrade shall be moist at the time of placing concrete. The subgrade shall be thoroughly wet the night before or at least six (6) hours prior to placing the concrete, and again sprinkled immediately before the concrete is placed on it. Sprinkling shall be such that mud and pools of water will not be formed. At the time of placing the concrete, the grade shall not be muddy, soft, or frozen.

409.03.04 Setting Forms. Before placing side forms, the underlying material shall be at the proper grade. Side forms shall have full bearing upon the foundation throughout their length and width of base and shall be placed to the required grade and alignment of the edge of the finished pavement. They shall be so supported that they will not deviate vertically at any time more than 0.01 foot from the grade established by the Engineer.

The maximum vertical deviation of the top of any side form, including joints, shall not exceed 0.01 foot from a twelve (12) foot straightedge, nor shall the inside face vary more than 0.02 foot from a twelve (12) foot straightedge. Stake pockets and interlocking devices shall be in such condition that they will prevent movement of the form.

Side forms shall be staked firmly by means of steel stakes at each end of the section and at intermediate points

not more than five (5) feet apart and shall be so designed that stakes may be driven through the base of the form. Forms shall be provided with means for locking stakes in position. Side form sections shall be laid with an expansion gap of approximately 0.01 foot. The stakes used in staking side forms shall be of sufficient length so that the side forms will be held firmly in place. Any lateral movement of forms greater than 0.02 foot while supporting moving equipment shall be considered as evidence that the steel stakes do not hold the side forms firmly in place and longer stakes shall be provided by the Contractor at his expense.

Immediately in advance of placing pavement and after all sub-grade operations are completed, side forms shall be trued and maintained to the required line and grade for a distance sufficient to prevent delay in placing the pavement.

Side forms shall remain in place until the day after placing the pavement, and in all cases until the edge of the pavement no longer requires the protection of the forms.

Side forms shall be thoroughly cleaned and oiled each time they are used and before pavement is placed against them.

409.03.05 Reinforcement. Concrete pavement shall be reinforced at structure approaches and other locations as shown on the plans or directed by the Engineer, and as specified in this section.

Bar reinforcement shall conform to the provisions in Section 505, "Reinforcing Steel."

Bar reinforcement shall be held accurately and firmly in position during the placing and compacting of the concrete without sagging by means of supporting devices which shall be left in place. The supports shall be specially manufactured for the purpose and each support shall be capable of supporting a vertical load of two hundred (200) pounds.

409.03.06 Mixing. Mixing of concrete shall conform to the provisions in subsections 501.03.06, "Machine Mixing," and 501.03.08, "Retempering," and in addition thereto shall meet the following requirements.

Suitable non-resettable batch counter shall be provided

and maintained in proper operating order, which will correctly indicate the number of batches proportioned at the batching plant and mixed in the mixers.

All concrete shall be homogeneous and thoroughly mixed in appearance, and there shall be no lumps or other evidence of undispersed cement.

Concrete mixed at the site of the work or in a central mixing plant, shall be mixed not less than fifty (50) seconds nor more than ninety (90) seconds. Four (4) seconds shall be added to the specified mixing time if timing starts the instant the skip reaches its maximum raised position. Mixing time ends when the discharge chute opens. Transfer time in multiple drum mixers is included in mixing time. The contents of an individual mixer drum shall be removed before a succeeding batch is emptied therein.

The batch shall be so charged into the drum that a portion of the mixing water shall enter in advance of the cement and aggregates. The flow of water shall be uniform and all water shall be in the drum by the end of the first fifteen (15) seconds of the mixing period. The throat of the drum shall be kept free of such accumulations as may restrict the free flow of materials into the drum.

409.03.07 Placing Concrete. The Contractor shall make adequate advance arrangements for preventing delay in delivery and placing of the concrete. An interval of more than forty-five (45) minutes between placing of any two consecutive batches or loads shall constitute cause for stopping paving operations and the Contractor shall make a contact joint at his expense at the location and of the type directed by the Engineer, in the concrete already placed.

Unless otherwise specified, concrete pavement shall be placed in twelve (12) foot traffic lane widths separated by contact joints as shown on the plans, or, at the option of the Contractor, the concrete pavement may be placed monolithic two or more lanes wide without a contact joint, but with a longitudinal weakened plane joint at each traffic lane line.

All concrete shall be used while fresh. The use of water for retempering any concrete will not be permitted.

Any concrete showing improper proportions of materials, including water, shall not be used in the pavement and any such unsatisfactory concrete shall be removed and disposed of by the Contractor at his expense.

The Contractor shall protect freshly placed concrete from damage by any cause and any damage shall be repaired by the Contractor at his expense.

Expansion joint material shall be protected while depositing fresh concrete adjacent thereto.

Concrete work shall be adequately barricaded in all directions to protect the work.

Equipment that damages the cement-treated base, as judged by the Engineer, will be prohibited from traveling thereon.

409.03.08 Spreading, Compacting, and Shaping. (a) Side Form Construction. The concrete shall be distributed uniformly with a mechanical spreader.

The spread concrete shall be vibrated, screeded, and tamped by a machine or machines.

The number and capacity of machines furnished shall be adequate to perform the work required at a rate equal to the progress of the mixer. Any delay in excess of fifteen (15) minutes in vibrating, screeding, and tamping shall constitute cause for stopping the mixer until the machines performing such work are again in proper position in the paving train.

Screeding and tamping shall be performed by making at least two complete passes over the entire area of the pavement. On the first pass, the tamper shall be adjusted to produce the proper tamping action and the tamping bar shall not be operated during the second pass unless otherwise directed by the Engineer. The screeds shall be adjusted to an elevation slightly above grade so that when properly consolidated and finished, the completed surface of the pavement will be at the established grade, true to the cross section shown on the plans, and free from porous areas. The tops of the forms or the adjacent pavement and the contact surface of the crawler tracks or wheels shall be kept clean by effective devices attached to the machine. The travel of the machine shall be maintained true without

lift, wobble, or other variation tending to affect precision screeding. The machine shall be of ample strength to withstand severe use and shall be fully and accurately adjustable to compensate for wear. During each pass of the machine, a roll of concrete shall be maintained ahead of the front screed for the entire width of pavement being placed and except when making an expansion joint, the machine shall not be operated beyond that point where the roll of concrete can be maintained. The intent of this specification is that the equipment shall produce a surface requiring minimum cutting during the floating and final finishing as specified in subsection 409.03.10, "Finishing."

Concrete required to be placed in widths less than a traffic lane may be compacted and shaped by a powered mechanical compacting and shaping machine, supplemented by hand methods as necessary. Where hand compaction is performed, the tamper shall be constructed of heavy plank which length exceeds the width of pavement by a minimum of one (1) foot; shall be shod with a heavy strip of metal for a tamping surface; and shall be stiffened adequately to maintain the required shape during use. For concrete production in excess of forty (40) cubic yards per hour, and where all compaction is performed by hand methods, not less than two tampers shall be used.

The hand tamper shall be used with a combined tamping and longitudinal motion raising it from the side form and dropping it to consolidate the concrete. A surplus of concrete shall be kept in front of the hand tamper and tamping shall continue until the required cross section is obtained and the mortar flushes slightly to the surface.

Where hand compaction is performed on grades in excess of five (5) percent, a light strike board constructed similar to the heavy tamper shall be used following the heavy tamper or tampers to correct any displacement caused by flow of the concrete.

(b) Slip-Form Construction. Slip-form paving equipment shall spread, consolidate, screed, and float-finish the freshly placed concrete in such a manner that a minimum of finishing with a hand float, as specified herein, will be required to provide a dense and homogeneous pavement.

The concrete shall be distributed uniformly into final position by the slip-form paver without delay.

The concrete, for the full paving width, shall be effectively consolidated by internal vibration with transverse vibrating units or a series of equally spaced longitudinal vibrating units. If a series of longitudinal vibrating units are used, they shall be equally spaced at intervals not to exceed two and one-half (2½) feet, measured center to center.

The term "internal vibration" specified in the above paragraph shall be construed to mean vibration by means of vibrating units located within the specified thickness of pavement section and a minimum distance ahead of the screed equal to the pavement thickness.

When concrete is being placed adjacent to an existing pavement, that part of the equipment which is supported on the existing pavement shall be equipped with protective pads on crawler tracks or rubber-tired wheels on which the bearing surface shall be offset to run a sufficient distance from the edge of the pavement to avoid breaking or cracking the pavement edge.

At locations inaccessible to slip-form paving equipment, concrete pavement shall be placed by methods and equipment conforming to the requirements for placing concrete in widths less than a traffic lane, as specified in subsection 409.03.08(a), "Side Form Construction." At such locations, the use of stationary side forms conforming to subsection 409.03.02(f)1, "Side Form" will be required. Locations inaccessible to the slip-form paving equipment shall be finished by the hand float method and equipment specified in subsection 409.03.10(c), "Hand Float Method."

409.03.09 Joints (a) General. Joints in pavement will be designated as longitudinal and transverse contact joints, transverse expansion joints, and longitudinal and transverse weakened plane joints, and shall be constructed as shown on the plans and in accordance with the following provisions.

All transverse joints shall be constructed at the angle to the centerline of the pavement shown on the plans, and

the faces of all joints both transverse and longitudinal shall be normal to the surface of the pavement.

All sawed joints shall be clean and free of all foreign material after completion of shoulder work and prior to acceptance of the contract.

Bent tie bars shall be bent at right angles approximately four (4) inches from one end to form a support resting on the subgrade. The free end of the bar shall be bent along the side form so as to lie parallel to the pavement edge. After the first lane of pavement is completed, the bar shall be straightened to the proper position before paving the adjoining lane. If an "S" shaped bend is formed in straightening the bar, the offset from a straight line shall not be more than 0.1 foot.

Straight tie bars shall be placed mechanically to a uniform depth of 0.33 foot for the longitudinal joints in a multi-lane monolithic pavement.

Tie bars may be bent at right angles against the form of the first lane constructed and straightened into final position before the concrete of the adjacent lane is placed, or in lieu of bent tie bars, approved two-piece connectors may be used.

(b) Contact Joints. Contact joints are those made by placing fresh concrete against hardened concrete at planned locations.

Concrete on both sides of longitudinal contact joints shall be connected with tie bars as shown on the plans.

When the plans require the construction of keyways, the grooved portion of the keyway shall be constructed as part of the pavement width being placed.

(c) Weakened Plane Joints. Weakened plane joints shall be formed by cutting a groove in the pavement with a power driven saw at the locations shown on the plans. The grooves shall be cut to a minimum depth of 0.17 foot and the width shall be the minimum width possible with the type of saw being used, but in no case shall the width exceed 0.02 foot. The sawed joint shall go through the pavement edge at full depth of cut. Every fourth planned transverse weakened plane joint in the initial lane of concrete and also the first joint immediately after the

transverse contact joint shall be sawed within twenty-four (24) hours after the concrete has been placed, unless otherwise permitted by the Engineer, the exact time to be determined by the Engineer. Every second planned transverse weakened plane joint shall be sawed within forty-eight (48) hours after placing the concrete, unless otherwise permitted by the Engineer, the exact time to be determined by the Engineer. The remaining longitudinal and transverse weakened plane joints may be sawed at such time, after twenty-four (24) hours, as the Contractor may elect, except they shall be completed before placing concrete in succeeding adjacent lanes and before permitting the Contractor's traffic or public traffic to use the pavement.

In succeeding lanes of the concrete pavement, transverse joints opposite those which have opened in the initial lane shall be sawed within twenty-four (24) hours after the concrete has been placed, the exact time to be determined by the Engineer, but in all cases not more than three (3) consecutive planned transverse weakened plane joints shall be omitted. The remaining longitudinal and transverse weakened plane joints may be sawed at such time, after twenty-four (24) hours, as the Contractor may elect, except they shall be completed before placing concrete in the succeeding adjacent lane and before permitting the Contractor's traffic or public traffic to use the pavement.

No sawing shall be done where volunteer transverse cracks exist. If a volunteer transverse crack falls within five (5) feet of the location of a proposed sawed joint, the sawed joint shall be omitted. Joints sawed in violation of the provisions in this paragraph will not be paid for.

When the pavement is cured by means of a curing seal, all portions of the seal which have been disturbed by sawing operations shall be restored by spraying the areas with additional curing seal.

The Contractor shall keep a standby power saw on the project at all times when concrete paving operations are under way.

At the option of the Contractor, longitudinal weakened plane joints at traffic lane lines in multi-lane monolithic

concrete pavement may be formed by placing a continuous strip of plastic or other material which will not react adversely with the chemical constituents of the concrete. The joint insert material shall be of such width and character that when placed vertically in the concrete it will not bond with the concrete and will form an effective weakened plane joint of 0.17 foot minimum depth. The joint material shall be inserted with a mechanical device that places the material in a continuous strip, except where intervening structures break the continuity of paving. Splices in the joint material will be permitted providing they are effective in maintaining the continuity of the joint material as placed. The joint material shall be placed in such manner that the top of the strip is not more than 0.01 foot below the finished surface of the concrete. The joint material shall not be deformed from a vertical position, either in the installation or in subsequent finishing operations performed on the concrete. The alignment of the finished joint shall be uniformly parallel with the centerline of the pavement and shall be free of any local irregularity which exceeds 0.04 foot measured by a twelve (12) foot straightedge, except for normal curvature of centerline alignment. During the placing of the strip, the mechanical installation device shall vibrate the concrete sufficiently to cause the concrete to flow evenly about the joint material producing homogeneous concrete free of segregation and rock pockets or voids.

(d) Transverse Expansion Joints. Transverse expansion joints shall be formed at structure approaches as shown on the plans and as specified herein.

Transverse expansion joints shall be formed by means of joint filler strips conforming to the provisions in Section 707, "Joint Materials," and placed as specified herein. The joint strips shall be firmly supported in position by metal holders and end supports. The supports shall be held firmly in position and shall remain in place after completion of the pavement.

The metal holders shall be fabricated of sheet steel not less than 16 gage. They shall be in the form of a deep channel, extending down on both sides of the joint strip

to a depth of not less than 0.37 foot. They shall be slotted and cut away as necessary, to allow the concrete to make contact with the joint strip at close intervals. The ends of the holders shall be spread to admit the end supports.

During placing and compacting the concrete, the joint holder and end supports shall be so secured as to insure against movement of the joint strip and to keep the top edge of the joint strip approximately 0.04 foot below the surface of the finished pavement. After the concrete has been placed and compaction completed, the metal holder may be removed and a suitable shallow metal channel substituted therefor which shall fit snugly over the top edge of the joint strip and shall remain there until the joint is edged.

Filler shall extend the full width of the concrete being placed less 0.04 foot and after the side forms have been removed, any concrete which has flowed around the ends of the joint filler shall be removed.

409.03.10 Finishing. (a) General. Unless adequate lighting facilities are provided by the Contractor, placing of concrete shall cease at such time so that finishing operations can be completed during daylight hours.

Necessary workmen shall remain at work long enough to complete the finishing and curing of the pavement.

At the start of each day's work, the Contractor shall mark at the edge of the pavement nearest the outside shoulder with an approved stamp, his name, the month, day, and year such section is placed, and the Engineer's station at the location of the joint. The stamp shall be approximately one (1) foot by two (2) feet in size and shall be furnished by the Contractor and the cost thereof will be included in the paving items.

In case fine cracks or hair checks appear in newly placed concrete before it is thoroughly set, water shall be applied to the concrete surfacing, in the form of a fine fog mist until the finishing operations are completed and the curing is applied.

(b) Machine Float Method. The surface of the concrete shall be finished smooth and true to grade by means of a machine float.

The number and capacity of machines furnished shall be adequate to perform the work required at a rate equal to the progress of the mixer. Any delay in excess of thirty (30) minutes in performing the preliminary finishing shall constitute cause for stopping the mixer until the machine or machines performing such work are again in proper position in the paving train.

The machine float shall be self propelled and designed to run on the side forms or adjacent lanes of concrete. When the machine float runs on the adjacent pavement, the pavement shall be protected as specified in subsection 409.03.02(a), "Equipment—General." The agggregate length of the floats in contact with the surface shall not be less than four (4) feet per foot of width of concrete being finished. The floats shall be of such length and shall be set at angles with the axis of the machine so as to effectively spread and smooth the surface of the concrete, eliminating unevenness and producing a surface texture of uniform appearance. The machine shall be equipped with a suitable full-width metal roller placed at one end ahead of all the floats, which roller will have the effect of more fully embedding the coarse aggregate in the cement mortar and of bringing a slight excess of mortar to the surface of the concrete. The machine shall be equipped with a suitable water tank and spraying device designed to keep the roller clean and to spray water on the concrete surface as directed by the Engineer. All floats shall be constructed of hardwood, steel, or be steel shod. The roller and floats shall be equipped with adjusting devices which will permit the independent adjustment of each to the required cross section of the pavement and which will permit the lowering and raising of the floats both individually and as a unit. The machine shall be capable of operating at speeds adequate to perform all finishing operations necessary. The speed of operation shall be such as to give the best results. Alternative equipment may be substituted for the

equipment provided for in this section, provided the finished surface conforms to the provisions specified herein.

(c) Hand Float Method. The surface of the concrete shall be finished smooth and true to grade with two wooden floats sixteen (16) feet long, one (1) inch thick and four (4) inches wide, rigidly ribbed and with adjusting screws between the rib and float bars at not more than two (2) foot centers, to insure a true and flat surface on the under side at all times. Each float shall be operated from the side of the pavement and the float shall be parallel with the centerline of the pavement. The edge of the float shall be used to cut down all high areas, and the material so removed shall be floated into the depressions until a true surface is obtained. Each successive passage of the float shall just lap the previous path. Upon completion of the passage, the float shall be brought back and the overlap between the two passages smoothed.

The floats shall be operated as far back of the tamping machine as the concrete remains workable and the number of passes shall be sufficient to remove all perceptible inequalities.

At least one spare float in good condition shall be available on the work at all times.

(d) Final Finish. After the preliminary finishing has been completed, the edges of an initial pavement lane shall be rounded to a one-half (½) inch radius. Transverse contact joints, expansion joints, and joints adjacent to an existing pavement shall be rounded to a one-fourth (¼) inch radius.

In advance of the curing operations, or as directed by the Engineer, the pavement shall be textured with a drag strip of burlap or other device which will produce scoring parallel to the centerline. The burlap drag shall consist of one or more pieces of burlap fastened to a cross member riding on the subgrade or side forms by means of wheels or skids to form a continuous strip of burlap the full width of the pavement. Drags shall be maintained clean and free from encrusted mortar. Drags that cannot be cleaned shall be discarded and new drags substituted.

Completed pavement that is found to have a surface texture which, in the opinion of the Engineer, would not provide satisfactory skid resistance, shall be ground or scored by abrasive means by the Contractor, at his expense, to provide a surface texture satisfactory to the Engineer.

409.03.11 Riding Tolerances. Upon completion of the pavement, any points that are high in excess of the straightedge tolerances set forth in subsection 409.02.03, "Concrete Properties and Tests," shall be removed by abrasive means as provided in this section.

Equipment that consistently produces a finished surface having a Profile Index of seven (7) inches per mile or less, shall be used. Should the Profile Index exceed the rate of seven (7) inches per mile, the paving operations shall be discontinued until other means and equipment are proposed for trial by the Contractor and are approved by the Engineer. Such revised methods and equipment shall be discontinued if they do not produce a finished surface having a Profile Index of seven (7) inches per mile, or less. Operations shall not be resumed until the Engineer approves further changes in methods and equipment as proposed by the Contractor.

In addition to the requirement for average Profile Index, all areas representing high points having deviations in excess of 0.3 inch as defined in the following paragraph, shall be reduced by abrasive means until such deviations as indicated by reruns of the profilograph do not exceed 0.3 inch. The deviations in excess of 0.3 inch shall be determined by measurement of the profilogram in accordance with Test Method No. Nev. T446.

After grinding has been completed to reduce all individual deviations in excess of 0.3 inch as provided in the above paragraph, additional grinding shall be performed if necessary to reduce the Profile Index, as measured by the profilograph to seven (7) inches per mile, or less, in any 0.1 mile section along any line parallel to the edge of the pavement.

Additional grinding shall be performed as necessary

to extend the ground area laterally to the nearest lane line or edge of pavement and longitudinally so that the grinding begins and ends at lines normal to the pavement centerline within any one ground area. It is the intent of this requirement that all ground areas be neat rectangular areas of uniform texture.

The profile index requirements herein will not apply to the pavement within thirty (30) feet of either end of a bridge. The finished surface of such pavement shall, however, meet all other requirements in this section.

409.03.12 Curing. (a) General. All Portland cement concrete pavement must be cured for seventy-two (72) hours by the methods specified in this section, subject to the conditions set forth in subsection 501.03.09(a), "Curing—General." In case of low temperatures, the curing period will be increased according to the provisions of subsection 501.03.10(b), "Cold Weather—General."

(b) Curing Compound Method. Curing by use of curing compound shall be as specified in subsection 501.03.09(c), "Curing Compound Method." The curing compound shall not be applied until all patching and surface finishing, except grinding, has been completed. When deemed necessary by the Engineer during periods of hot weather, fogging of the concrete with water shall be continued after curing compound is applied until the Engineer determines that a cooling effect is no longer required. Such fogging after the application of the curing compound will be paid for as extra work as provided in subsection 104.03, "Extra Work."

(c) Waterproof Paper Method. Curing by use of waterproof membrane material shall be as specified in subsection 501.03.09(d), "Waterproof Paper."

409.03.13 Protection of Pavement. Concrete shall not be placed on frozen ground nor shall it be mixed or placed while the atmospheric temperature is below thirty-five (35) degrees Fahrenheit, unless adequate means are employed to heat the aggregates and water, and provision satisfactory to the Engineer has been made for protecting the work.

Placing concrete shall be stopped before the quantity of rainfall is sufficient to cause a flow or wash the surface.

Upon written notice from the Engineer, all concrete which has been damaged shall be replaced by the Contractor at his expense.

All concrete in pavement shall be protected from freezing or frost for a period of five (5) days after placing. The temperature of the surface of the concrete shall not be allowed to drop below forty (40) degrees Fahrenheit for this period of five (5) days.

When ordered by the Engineer or shown in the contract documents, pavement crossings shall be constructed for the convenience of public traffic. The material and work necessary for the construction of such ramps, and their subsequent removal and disposal, will be paid for at the contract unit prices for the items of work involved and if there are no contract items for the work involved, payment for pavement crossings will be made by force account work as provided in subsection 104.03, "Extra Work." Where public traffic will be required to cross over the new pavement, Type III Portland cement shall be used in concrete. When Type III Portland cement is used in concrete, and if permitted in writing by the Engineer, the pavement may be opened to traffic as soon as the concrete has developed a modulus of rupture of four hundred fifty (450) pounds per square inch.

No traffic or Contractor's equipment, except for subgrading equipment, will be permitted on the pavement before a period of ten (10) calendar days has elapsed after the concrete has been placed, nor before the concrete has developed a modulus of rupture of at least four hundred fifty (450) pounds per square inch, as determined by Test Method No. Nev. T442. Concrete that fails to attain a modulus of rupture of four hundred fifty (450) pounds per square inch within ten (10) days shall not be opened to traffic until directed by the Engineer.

Equipment used to prepare subgrade may be permitted to ride upon one edge of the previously placed concrete at the end of seventy-two (72) hours, provided, however, that no damage is done to the pavement edge by reason

of such operations. Any damage to the pavement resulting from such operations shall be repaired by the Contractor at his expense prior to placing the adjacent lane.

METHOD OF MEASUREMENT

409.04.01 Measurement. The number of square yards of concrete pavement to be measured for payment will be determined from horizontal measurements of the completed finished surface of the pavement, except that the area for payment for approach slabs to structures and pavement end anchors will be determined by computing the total specified compacted volume of material in the slabs and anchors and converting such volume to an equivalent area based on the thickness of pavement placed on the traveled way.

The quantity of tie bars will be determined from actual count of bars placed.

The length of sawed transverse weakened plane joints shall be the length in feet of the transverse weakened plane joints actually sawed except as otherwise provided in subsection 409.03.09(c), "Weakened Plane Joints." Volunteer cracks will not be included in the length of transverse weakened plane joints measured for payment. No measurement or separate payment will be made for longitudinal joints.

409.04.02 Pavement Thickness. It is the intent of the specifications that concrete pavement shall be constructed in accordance with the thickness requirements of the plans and specifications. Tolerances allowed for subgrade construction and other specification provisions which may affect thickness shall not be construed to modify such thickness requirements.

It is agreed by the parties that compliance with the thickness requirements for concrete pavement will be determined by the Engineer in accordance with the provisions in this subsection. It is further agreed by the parties that the liability of the Contractor for failure to comply with such thickness requirements and the rights of the State in the event of such failure shall likewise be governed by the provisions in this subsection.

For the purposes of these specifications, the primary unit of pavement will be the area of pavement placed in each day's paving operations. Within such primary unit of pavement, there may be an area or areas which have been determined to be a secondary unit or units of pavement, as provided in subsection 409.04.02(b), "Thickness Deficiency of More than 0.05 Foot." In such case, the primary unit area will be reduced by the secondary unit area included therein.

At such time after the concrete pavement has been placed, as is determined by the Engineer to be appropriate, thickness measurements will be made in each primary unit of pavement at the rate of not less than one measurement for each one thousand (1,000) linear feet of traffic lane, or fraction thereof, of pavement placed. The exact location and number of thickness measurements within each primary unit, both longitudinally and transversely, will be as determined by the Engineer. In general, thickness measurements will be made at approximately uniform intervals throughout each primary unit of pavement.

If required, secondary thickness measurements will be made as provided in subsection 409.04.02(b), "Thickness Deficiency of More than 0.05 Foot."

Pavement thickness variation, if any, from the thickness requirements of the plans and specifications will be determined by comparing the actual thickness measurement with the thickness specified at the location where the measurement was made. Such variation will be determined to the nearest 0.01 foot as either excess or deficient thickness.

(a) Thickness Deficiency of Not More Than 0.05 Foot. If the thickness measurements in a primary unit are deficient in thickness by not more than 0.05 foot, thickness variations in such unit will be averaged, algebraically, to the nearest 0.01 foot, to determine the average thickness deficiency, if any, in said primary unit. For the purpose of determining the average thickness deficiency, an excess thickness variation of more than 0.02 foot greater than the thickness specified will be considered to be 0.02 foot greater than the specified thickness.

For each primary unit of pavement which is deficient in average thickness, the Contractor shall pay to the Department as liquidated damages, or the Department, at its option, may deduct from any money due, or to become due the Contractor from the Department, an amount set forth in the following schedule:

Average Thickness Deficiency (feet)	Deficiency Adjustment (dollar per square yard)
0.01	0.10
0.02	0.25
0.03	0.45
0.04	0.70
0.05	1.00

(b) Thickness Deficiency of More Than 0.05 Foot. For each thickness measurement made in a primary unit by the Engineer that is deficient in thickness by more than 0.05 foot, the Engineer will determine from secondary thickness measurements the dimensions of the secondary unit area where the apparent thickness deficiency is more than 0.05 foot. The determination of the limits of said secondary unit area will be made by making secondary thickness measurements in each panel of pavement adjacent to the panel in which the original measurement in the primary unit was made. This procedure will continue, regardless of unit boundaries, until such secondary unit area is bounded by panels in which the secondary measurement is deficient in thickness by 0.05 foot or less.

Panels are the areas bounded by longitudinal and transverse joints and pavement edges. If a transverse weakened plane joint has been omitted at the location where a volunteer crack exists, in accordance with the provisions in subsection 409.03.09(c), "Weakened Plane Joints," the volunteer crack will be considered as a transverse joint only if the pavement adjacent thereto is not to be removed and replaced. If either longitudinal or transverse joints, or both, are eliminated by the special provisions or plans, the limits of panels will be determined by the Engineer as if such joints had been constructed.

The secondary unit area will be made up of entire panels only.

Each panel in which secondary thickness measurements are made pursuant to the provisions in this subsection will be deemed to be, in its entirety, of the thickness shown by such measurement.

After the Engineer has determined the limits of the secondary unit area, he will further determine, within such area, which panels, if any, will be required to be removed and replaced in accordance with procedure 1, below, and the panels, if any, which will remain in place in accordance with procedure 2, below:

1. The Contractor shall, at his expense, remove and replace the concrete pavement in such panels with concrete pavement meeting the thickness and all other requirements of the contract documents. If the area to be removed is not bounded by longitudinal or transverse joints, the Contractor shall saw, at his expense, weakened plane joints at the location designated by the Engineer, conforming to the provisions in subsection 409.03.09(c), "Weakened Plane Joints." Subgrade shall be lowered as necessary to meet the full thickness requirements. Replaced pavement will be tested for thickness compliance by means of additional secondary measurements and will be subject to all of the thickness requirements of the specifications.

2. The Contractor shall leave such panels of pavement in place without payment, if they meet all of the other requirements of the contract documents.

The cost of all secondary thickness measurements made in accordance with the provisions in this subsection, including filling of any necessary holes with concrete, will be deducted from any money due, or that may become due, the Contractor under the contract.

After eliminating the secondary unit area, or areas, and the thickness measurements therein from consideration, the average thickness deficiency, if any, of the remainder of primary unit areas will be determined as provided in subsection 409.04.02(a), "Thickness Deficiency of Not More Than 0.05 Foot." Secondary thickness measurements made outside of a secondary unit area may be used to determine average thickness deficiency, if any, in the remaining primary unit area in which they are taken.

The Contractor shall not be entitled to any additional compensation or extension of time due to any of the provisions in this subsection.

No additional compensation will be allowed the Contractor for any pavement constructed in excess of the thickness requirements of the contract documents.

If the Contractor believes that the number of thickness measurements made in primary unit areas by the Engineer in accordance with the provisions in this subsection are insufficient to fairly indicate the actual thickness of pavement placed, he may request that additional thickness measurements be made by the Engineer and such additional measurements will be used in determining the average thickness variation. The location of all such additional thickness measurements will be determined by the Engineer. The cost of all such additional measurements made, including filling of any necessary holes with concrete, will be deducted from any money due, or that may become due, the Contractor under the contract.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

409.05.01 Payment. The accepted quantities measured as provided in subsection 409.04.01, "Measurement" and 409.04.02, "Pavement Thickness," will be paid for at the contract unit price bid per square yard for Portland cement concrete pavement, per each for tie bars and per linear foot for saw transverse weakened plane joints.

The above prices shall be full compensation for furnishing all the material including Portland cement and water, mixing, hauling, placing, finishing, and incidentals necessary for doing all the work as shown on the plans or established by the Engineer.

Full compensation for furnishing and placing all materials used in constructing transverse expansion joints at structure approaches, as indicated on the plans, shall be considered as included in the contract price paid per square yard for concrete pavement and no additional compensation will be allowed therefor.

Reinforcement will be paid for as provided in Section 505, "Reinforcing Steel."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Partial payments for Portland cement concrete pavement may be made as set forth under subsection 109.06, "Partial Payments."

Payment will be made under:

Pay Item	Pay Unit
Portland Cement Concrete Pavement (..... inches)	Square Yard
Tie Bars	Each
Saw Transverse Weakened Plane Joints	Linear Foot

SECTION 501

PORTLAND CEMENT CONCRETE

DESCRIPTION

501.01.01 General. This work shall consist of Portland cement, fine aggregate, coarse aggregate, water and when specified, an air-entraining admixture, proportioned, placed, and cured as herein specified.

MATERIALS

501.02.01 General. Materials shall meet the requirements of the following sections and subsections:

Water	Section 722
Aggregate for Portland Cement Products	Section 706
Portland Cement	Section 701
Concrete Curing Materials and Admixtures	Section 702

501.02.02 Gradation Requirements. The gradation requirements represent the extreme limits in determining the suitability of material. The gradation from any one source shall maintain a uniformity such that variations in the fineness modulus will not exceed $\pm$ 0.2 from the fineness modulus of samples of the material offered for use. Fine aggregate from any one source having a variation in fineness modulus of more than 0.2 as prescribed above shall be rejected, or at the discretion of the engineer, may be accepted subject to such approved changes. The fineness modulus of fine aggregate shall be determined by adding the cumulative percentages, by weight, of material retained on each of U.S. Standard sieves Nos. 4, 8, 16, 30, 50, and 100, and dividing by 100.

Fine aggregates from different sources of supply shall not be mixed or stored in the same pile. They shall not be used alternately in the same class of construction or job-mix without written permission of the Engineer. Such permission shall be contingent on amending the job-mix and batch weights as necessary to protect the quality of the concrete produced.

If the fine aggregate for a job-mix is to be a composite material from two or more sources, material from respective sources shall be proportioned separately or blended by methods which will maintain the degree of uniformity or gradation required by these specifications.

Adequate supplies of aggregate shall be produced and stockpiled sufficiently in advance of construction operations as to permit sampling and testing before use.

Coarse aggregates secured from the same or different sources and which vary widely in gradation shall be placed in separate stockpiles or bins and recombined in proportions approved by the Engineer. Different sizes of aggregates shall be stored in stockpiles sufficiently removed from each other to prevent the materials at the edges of piles from becoming intermixed.

If the Contractor changes the source of any size of aggregate, opportunity shall be given in advance of use to permit the Engineer to determine the concrete-making properties as provided in subsection 501.02.04, "Concrete Making Properties."

501.02.03 Admixtures. Air-entraining admixtures and water reducers and retarders shall conform to the requirements of subsection 702.03.03, "Air-Entraining Admixtures" and 702.03.04, "Water Reducers and Retarders."

No admixtures shall be used without written permission from the Engineer, except as otherwise provided in these specifications or in the special provisions.

Admixtures shall not be used to replace cement. Admixtures containing chlorides as CL^- in excess of one (1) percent by weight shall not be used in prestressed concrete. If admixtures are used to entrain air, to reduce the water-cement ratio, to retard or accelerate setting time, or to accelerate the development of strength, they shall be used at the rate of dosage specified in the contract documents or as approved by the Engineer.

When the use of an air-entraining agent is specified, it shall be added in a quantity conforming to Table I of subsection 501.03.04, "Classifications and Proportions." It shall be measured accurately into each batch by equipment and methods approved by the Engineer. Adjustments shall

be made in the weights of the aggregates used per batch to compensate for increased yield due to air-entrainment so that the quantities of cement per cubic yard of concrete remain constant. Such adjustments shall be made by decreasing the weight of fine aggregate without changing the weight of coarse aggregate unless otherwise approved by the Engineer.

Admixtures shall be measured accurately into each batch by methods approved by the Engineer.

Except as otherwise provided for air-entraining agents, samples of admixtures proposed for use shall be submitted by the Contractor to the Engineer in advance of intended use sufficiently to permit tests to be made to determine compliance with claimed properties.

Any type of admixture shall be uniform in properties throughout its use in the work. Should it be found that the admixture as furnished is not uniform in properties, its use shall be discontinued.

Admixtures shall be dispensed in liquid form. Dispensers for liquid admixtures shall have sufficient capacity to measure at one time the full quantity required for each batch. Unless liquid admixtures are added to premeasured water for the batch, their discharge into the batch shall be arranged to flow uniformly into the stream of water. Dosages of liquid admixtures shall not vary from the dosage approved by the Engineer by more than five (5) percent. Equipment for measurement shall be designed for convenient confirmation of the accuracy of measurement. If more than one liquid admixture is used, each shall be dispensed by separate equipment unless otherwise permitted in writing by the Engineer.

When water-reducing agents or water-reducing retarders are used, the permitted dosage of the admixture shall not exceed that which will result in an increase in the drying shrinkage of the concrete in excess of twenty (20) percent when used in precast, prestressed concrete; ten (10) percent when used in cast-in-place prestressed concrete; ten (10) percent when used in cast-in-place reinforced concrete; or three (3) percent when used in non-reinforced concrete pavements.

Water reducers shall reduce the water demand of concrete for a given slump at least seven (7) percent when used at the maximum dosage recommended by the manufacturer. Set retarders shall not be used in greater dosages than those recommended by the manufacturer, nor more than that needed to obtain the desired retardation. The strength of the concrete containing the admixture in the amount approved by the Engineer, shall at the age of forty-eight (48) hours and longer, be not less than that of similar concrete without the admixture.

When the contractor proposes to use an air-entraining admixture which has been previously approved, he shall submit a certification stating that the admixture is the same as that previously approved. If an admixture offered for use is essentially the same (with only minor differences in concentration) as another previously approved material, a certification will be required stating that the product is essentially the same as the approved admixture and that no other admixture or chemical agent is present.

Either prior to or at any time during construction, the Engineer may require that the admixture selected by the Contractor be further tested to determine its effect upon the strength of the concrete. When so tested, seven (7) day compressive strength of concrete made with the cement and aggregates in the proportions to be used in the work and containing the admixture under test shall not be less than eighty-eight (88) percent of the strength of concrete made with the same materials and with the same cement content and consistency but without the admixture.

501.02.04 Concrete Making Properties. Portland cement concrete shall be subject to the following requirements and test methods:

Test	Test Designation	Requirements
Compressive Strength of Molded Concrete Cylinders	Nev. T475*	Table I
Making and Curing Concrete Compression and Flexure Test Specimens in the Laboratory	Nev. T455	.....
Making and Curing Concrete Compression Test Specimens in the Field	Nev. T428	.....
Unit Weight and Cement Factor, Fresh Concrete	Nev. T435	Table I
Air Content	Nev. T432	Table I
Method of Test for Specific Gravity and Absorption of Coarse Aggregate	Nev. T492	Min. saturated surface dry condition
Method of Test for Specific Gravity and Absorption of Fine Aggregate	Nev. T493	Min. saturated surface dry condition
Slump	Nev. T439 or Nev. T438†	Table I
Coring Concrete	ASTM C42‡	Informational

*A test shall be defined as the average of the breaking strength of three cylinders at twenty-eight (28) days. Cylinders will be required for each fifty (50) cubic yards, or portion thereof, placed each day. On small structures such as manholes, inlets, culverts, wingwalls, etc., the Engineer may vary the number for small placements to tests for each twenty-five (25) cubic yards placed over a several-day period. Other cylinders may be broken for informational purposes at various intervals when deemed advisable by the Engineer.

†Test method to be determined by the Engineer.

‡When compressive strength tests as determined by Test Method No. Nev. T475 show compressive strengths less than the minimum required in Table I and liquidated damages are assessed in accordance with subsections 502.04.01, and 504.04.01, "Method of Measurement," then the Contractor may, at his option, core the concrete in question according to ASTM C42 and break three drilled specimens therefrom. The test specimens will be taken at a location approved by the Engineer and in his presence. The average compressive strength of the three drilled specimens shall be used as the test result. The test shall be performed by a certified testing laboratory approved by the Department. Test Method ASTM C42 shall be accomplished as soon after the twenty-eight (28) day compressive strength tests as possible and in no case shall they be recognized as valid when more than twenty-eight (28) calendar days have elapsed from the time the Contractor has been notified in writing by the Engineer. The average of the compressive strengths of the drilled specimens as determined by Test Method ASTM C42 shall be the referee in determining liquidated damages. Compressive strength test results shall be correlated to the twenty-eight (28) day compressive strength requirement by Chart No. 1. Costs of performing the coring and related tests shall be borne by the Contractor.

CHART NO. 1
CONCRETE STRENGTH P.S.I.
DAYS
4000
3500
3000
2500
39
38
37
36
34
33
32
31
29
28
27
26
28 30 35 40 45 50 55 60 65 70 75
3000 50 2900 50 2800 50 2700 50 2600

CONSTRUCTION

501.03.01 Equipment. Methods employed in performing the work, and all equipment, tools, and machinery used for handling materials and executing any part of the work, shall be subject to the approval of the Engineer. All equipment necessary shall be on hand and approved before concrete operations are begun by the Contractor.

The Contractor shall maintain the equipment in good condition and adjustment. Concrete mixers and other equipment which are not adequate or suitable for the work shall be removed and suitable equipment shall be provided by the Contractor.

501.03.02 Protecting and Sampling Cement. Suitable means of storing and protecting the cement against moisture or other injurious effects shall be provided by the Contractor. Sacked or bulk cement which, for any reason, has become partially set or which contains lumps of caked cement shall be rejected and shall be immediately removed from the worksite.

Different brands of cement shall not be mixed during use or in storage, nor shall they be used alternately in any one structure. The same brand and kind of cement shall be used in a given structure above the ground line.

The sacked cement shall be so piled as to permit access for tally, inspection, and identification of each shipment.

The Contractor shall obtain from the cement company from which the cement is purchased, a certificate stating that the cement delivered to the work complies with the specifications for the type of cement specified for use. The certificate shall be dated, signed, and indicate the quantity of shipment. Two copies shall be delivered directly to the Engineer in charge of the work.

Upon receipt of the certificate of compliance, the Engineer may permit the use of the cement. When a certificate of compliance is not furnished the Engineer, the cement shall not be used in the work until a release for its use has been received by him from the Department's Materials and Research Division.

When a certificate of compliance is not furnished, the

Department shall be afforded sufficient time to make a seven (7) day test on approved brands of cement in common use, and a twenty-eight (28) day test on new or unapproved brands of cement.

Whenever it is determined by subsequent laboratory tests of mill or field samples that the cement does not comply with the specifications, subsequent use of cement from the same cement company will be delayed, if required by the laboratory, until tests can be made on each lot of cement delivered.

All cement not conforming to the specifications and all cement damaged by exposure to moisture shall be removed immediately and permanently from the work.

501.03.03 Storage of Aggregates. The handling and storage of aggregates shall be such as to prevent segregation or contamination by foreign materials.

In placing materials in storage or in moving them from storage to the mixer, any method which may cause the segregation, degradation, or the combining of material of different gradings which will result in any stockpile or bunker failing to meet specified requirements shall be discontinued and the materials shall be reprocessed or wasted.

501.03.04 Classifications and Proportions. The Contractor shall notify the Engineer not less than thirty-two (32) calendar days in advance of use of the proposed sources of materials and shall make arrangements for the Engineer to obtain samples as required for testing purposes.

When requested by the Contractor, exceptions to the above requirement may be granted in writing by the Engineer under either of the following conditions:

(a) The concrete structures on the project are minor in nature, such as culvert headwalls, manholes, small boxes, sidewalks, etc., generally, when less than one hundred (100) cubic yards of concrete are called for on the project.

(b) When the aggregate source has been previously tested within the past one (1) year and accepted by the State.

TABLE I

Class of Concrete	Cem. Range, Sacks Per Cu. Yd.	Coarse Agg. Size No.	Max. Water, Gal. Per Sack Cem.*	Min. Comp. Str. (28 day) PSI	Slump Range, Inches†	Air Range, Percent	Unit Weight Variation	Use
A‡	6.0–7.5	467	6	3,000	1–4	.....	± 3 lbs.	General use and reinforced structures
AA‡	6.0–7.5	467	6	3,000	1–4	3–5	± 3 lbs.	
B	5.5–7.5	357	6	3,000	1–5	.....	± 3 lbs.	Massive or lightly reinforced sections
BA	5.5–7.5	357	5.5	3,000	1–4	3–5	± 3 lbs.	
C	5.0–6.5	357	6.75	2,500	1–5	.....	± 3 lbs.	Massive unreinforced and backfill
CA	5.5–7.0	357	5.75	2,500	1–5	3–5	± 3 lbs.	
D	6.0–7.5	67	6	3,000	1–5	.....	± 3 lbs.	Thin reinforced sections, handrails, etc.
DA	6.0–8.0	67	6	3,000	1–4	3–5	± 3 lbs.	
PAA	6.0–8.0	67	6	Specified on Plans	0–4	0–5	± 3 lbs.	Prestressed members

*Based on aggregate in a saturated surface dry condition.

†When the deck of a structure is used as a riding surface the slump shall conform to that prescribed in subsection 409.03.01, "Classification and Proportions."

Slump indicated is in inches by Test Method No. Nev. 438 (cone). However, slump by Test Method No. Nev. 439 (Kelly Ball) may be used. The difference in slump, determined by comparing slump tests on two samples of mixed concrete for each individual batch tested, shall not exceed two (2) inches. When the difference in slump does exceed two (2) inches, procedure and equipment used in producing the concrete shall be adjusted to reduce the difference in slump to not more than two (2) inches.

‡In case reinforcing steel is too tightly knit for course aggregate to fit between the steel, the Engineer may allow a change in the class of concrete to D or DA.

Samples will not exceed five hundred (500) pounds for each separate grading. The Contractor shall furnish a written statement giving the cement factor in sacks per cubic yard, the proportions of cement, water, and each size of aggregate by weight in a saturated surface dry condition, and the percentage of air in the concrete proposed for use in the work. If the Contractor proposes to use an admixture other than an air-entraining agent, he shall state its complete brand name and the quantity proposed to be used per sack of cement.

Portland cement concrete shall be proportioned, using the aggregates tested, such that the compressive strength requirements in Table I will be satisfied without falling below the minimum, or exceeding the maximum values given. The Contractor shall give the Engineer advance notice in writing when any changes are to be made in the batch proportions.

Batches of concrete shall not vary more than $\pm$ three (3) pounds per cubic foot in unit weight from design mix. The cement factor of any individual batch placed in the work shall not be more than 0.15 sack per cubic yard less, nor more than 0.25 sack per cubic yard greater than the designated factor (sacks of cement per cubic yard). Aggregates shall be batched and reported to the resident engineer. The weights used may be varied as necessary to comply with the above tolerances in cement factor and unit weight.

501.03.05 Proportioning Methods. Except as hereinafter noted, aggregate bins shall conform to either (a) or (b) as follows:

(a) Each specified size of aggregate shall be stored in a separate bin. Except as hereinafter specified, each bin shall be provided with an individual outlet gate, designed and constructed to prevent leakage when closed. The gates shall cut off quickly and completely.

(b) Each size aggregate shall be weighed individually in a single bin, providing there is a satisfactory method employed to eliminate any excess material resulting from over-charging of the bin before the material reaches the surge hopper.

(a) and (b) above will not be required when batching for culvert headwalls, manholes, small boxes, sidewalks, etc., and the total quantity of class A, AA, D, DA, concrete called for on the project does not exceed 300 cubic yards.

All aggregates for use in Portland cement concrete shall be proportioned by weight, with the exception that aggregates for culvert headwalls, short pieces of curbs and gutter, or small sections of sidewalk and related minor work may be proportioned either by weight or volume as the Contractor may elect. Measuring boxes of known capacity shall be furnished and used to measure each size of aggregate proportioned by volume.

Batches requiring fractional sacks of cement will not be permitted, unless the Contractor elects to weigh the cement in each batch.

Bulk cement shall be weighed separately when the batch is one (1) cubic yard or more. The scale and weigh hopper for the cement shall be separate and distinct from the aggregate hopper or hoppers. The discharge mechanism of the bulk cement hopper shall be interlocked against opening before the full amount of cement is in the hopper, against closing before the contents of the hopper are entirely discharged and the scales are back in balance, and against opening when the amount of cement in the hopper is underweight by more than one (1) percent of the amount specified. An interlock system will not be required on projects having less than three hundred (300) cubic yards in the bid schedule.

Scales utilized in the proportioning device may be of the springless dial type or of the multiple beam type.

If of the dial type, the dial shall be of such size and so arranged that it may be read easily from the operating platform.

If of the multiple beam type, the scales shall be provided with an indicator operated by the main beam which will give positive visible evidence of over or under weight. The indicator shall be so designed that it will operate during the addition of the last four hundred (400) pounds of any weighing. The over travel of the indicator hand shall be at

least one-third of the loading travel. The indicator shall be enclosed against moisture and dust.

Weighing equipment shall be insulated against vibration or movement of other operating equipment in the plant. When the entire plant is running, the scale reading and cut-off shall not vary from the weight designated by more than one (1) percent for cement and one and one-half (1½) percent for any size of aggregate, nor one (1) percent for the total aggregate in any batch.

Scales shall be approved with a certificate of inspection as required in subsection 109.01, "Measurement of Quantities."

Should separate supplies of aggregate and material of the same size group, but of different moisture content or specific gravity be available at the proportioning plant, withdrawals shall be made from one supply exclusively and the material therein completely exhausted before starting upon another.

Stockpiled aggregates shall be in a saturated surface dry condition just prior to batching. The moisture content of the aggregate shall be such that no visible separation of moisture and aggregate will take place during transportation from the proportioning plant to the point of mixing. Aggregate containing excess moisture shall be stockpiled prior to use until sufficiently dried to meet the above requirements.

Batches with cement in contact with damp aggregates shall be mixed within thirty (30) minutes after being proportioned. Batch trucks hauling more than one batch of cement and aggregate shall be so constructed that materials do not flow from one compartment to another during haul or discharge.

Coarse and fine aggregate shall be handled and measured separately. Each bag of cement shall contain ninety-four (94) pounds net and shall be emptied directly into charging skip of the mixer. Water shall be measured either by volume or by weight.

The equipment for measuring and supplying the water to the mixer shall be so constructed and arranged that the amount of water added to the mixture can be measured positively and that the predetermined quantity of water

required can be discharged rapidly in one operation into the mixing drum without dribbling. The equipment shall be so designed that water from the source of supply cannot enter the measuring tank while the water is being discharged from the measuring tank into the mixer. Tanks or other equipment for measuring and discharging water into the mixer shall be sufficiently accurate that the amount of water delivered to the mixer for any batch shall not vary more than one (1) percent from the required quantity of water for any position of the mixer with respect to level plane. The tanks or other equipment shall be so arranged as to permit the checking of the amount of water delivered by discharging into measured containers.

501.03.06 Machine Mixing. (a) General. All concrete shall be mixed in mechanically operated mixers, except that when permitted by the Engineer, batches not exceeding one-third (⅓) cubic yard may be mixed by hand methods in accordance with the provisions of subsection 501.03.07, "Hand Mixing." Mixers shall have legible permanently attached plates showing manufacturer's rated capacity, mixing speeds, and serial number.

Mixers may be stationary mixers or truck mixers. Agitators may be truck mixers operating at agitating speed or truck agitators. Each mixer and agitator shall have attached thereto in a prominent place a metal plate or plates on which is plainly marked the various uses for which the equipment is designed, the manufacturer's guaranteed capacity of the drum or container in terms of the volume of mixed concrete and the speed of rotation of the mixing drum or blades.

The Contractor, at his expense, shall furnish samples of the fresh concrete and provide safe and satisfactory facilities for obtaining the samples.

Concrete mixers may be of the revolving drum or the revolving blade type and the mixing drum or blades shall be operated uniformly at the mixing speed recommended by the manufacturer.

The temperature of materials as charged into the mixer shall be such that the temperature of the mixed concrete at the time it is placed in final position is not less than fifty

(50) degrees Fahrenheit nor more than ninety (90) degrees Fahrenheit. Aggregates and water used for mixing shall not exceed one hundred fifty (150) degrees Fahrenheit.

Concrete for structures shall be mixed for a period of not less than sixty (60) seconds nor more than five (5) minutes after all materials, including water, are in the mixer.

Cement shall be batched and charged into the mixer by means that will not result either in loss of cement due to the effect of wind, or in accumulation of cement on surfaces of conveyors or hoppers, or in other conditions which reduce or vary the required quantity of cement in the concrete mixture.

Stationary mixers having a capacity of one (1) cubic yard or more and all paving mixers shall be operated with an automatic timing device that can be locked by the Engineer. The time device and discharge mechanisms shall be so interlocked that during normal operations no part of the batch will be discharged until the specified mixing time has elapsed.

The total elapsed time between the intermingling of damp aggregates and cement and the start of mixing shall not exceed thirty (30) minutes.

Mixers and agitators which have an accumulation of hard concrete or mortar or worn blades shall not be used.

When central-mixed concrete is furnished and non-agitating hauling equipment is used for transporting concrete to the delivery point, for Portland cement concrete pavement, discharge into the laydown machine shall be completed within forty-five (45) minutes after the addition of the cement to the aggregates.

(b) On-Site Mixed Concrete. When mixing at the site of the work the mixers used shall be of the paving or stationary type. The size of batch shall not exceed the rated capacity as determined by the standard requirements of the Associated General Contractors of America, except that in paving mixers when used for Portland cement concrete pavement, concrete slope protection, and curbs and sidewalks, the size of batch may exceed the rated capacity of the mixer as determined by the standard requirements of the Associated General Contractors of America to a

total of 32.4 cubic feet in 27 E mixers and 40.8 cubic feet in 34 E mixers, provided that all parts of the mixer will hold the overcharge without spillage, that the uniformity and strength of the resulting concrete is not reduced, and provided further that when paving mixers are operating on grades in excess of six (6) percent, the size of batch shall not exceed 29.7 cubic feet in 27 E mixers nor 37.4 cubic feet in 34 E mixers.

(c) Ready-Mixed Concrete. Ready-mixed concrete shall include central-mixed, shrink-mixed and transit-mixed concrete. Shrink-mixed concrete is that which has been mixed partially in a stationary mixer and the mixing completed in a truck mixer.

The size of batch in truck mixers and truck agitators shall not exceed the rated capacity as determined by the current Standard Requirements of Truck Mixer Manufacturers Bureau. The size of batch in stationary mixers shall not exceed the rated capacity of the mixer as determined by the standard requirements of the Associated Contractors of America. No batches requiring fractional sacks of cement will be permitted unless all of the cement is weighed when added to the batch.

If the use of ready-mixed concrete is approved, the producer shall use only that cement approved by the State for use on the project. State approved cement shall be stored at the concrete plant in such a manner that it can be identified and kept separate from other cement.

Ready-mixed concrete for structures shall be transported in truck mixers or truck agitators.

The mixer, when loaded to capacity, shall be capable of combining the ingredients of the concrete within the specified time, into a thoroughly mixed and uniform mass and of discharging the concrete with a satisfactory degree of uniformity. The agitator, when loaded to capacity, shall be capable of maintaining the mixed concrete in a thoroughly mixed uniform mass and of discharging the concrete with a satisfactory degree of uniformity.

Mixers and agitators shall be examined periodically for changes in condition due to accumulation of hardened concrete or mortar or to wear of the blades. When any such

change of condition is found, the concrete should be subjected to the slump tests. If the tests indicate that the concrete is not being properly mixed, the faulty equipment shall be corrected before its further use is allowed.

Truck mixers shall be equipped with electrically or mechanically actuated revolution counters by which the number of revolutions of the drum or blades may be readily verified. The counters shall be of the continuous-registering, non-resettable type, which accurately register the number of revolutions, and shall be mounted on the truck mixer so that the Engineer may safely and conveniently inspect them from alongside the truck.

When a truck mixer is used, each batch of concrete shall be mixed for not less than seventy (70) nor more than one hundred (100) revolutions of the drum or blades at the rate of rotation designated by the manufacturer of the equipment as mixing speed. If any additional mixing is done, it shall be at the speed designated by the manufacturer of the equipment as agitating speed.

When shrink-mixed concrete is furnished, concrete that has been partially mixed at a central plant shall be transferred to a truck mixer and all requirements for transit-mixed concrete shall apply. No credit in the number of revolutions at mixing speed shall be allowed for partial mixing in a central plant.

No additional mixing water shall be incorporated into the concrete during hauling or after arrival at the delivery point, unless permitted by the Engineer. If the Engineer permits additional water to be incorporated into the concrete, the drum shall be revolved not less than thirty (30) revolutions at mixing speed after the water is added and before discharge is commenced.

The rate of discharge of mixed concrete from truck mixer-agitators shall be controlled by the speed of rotation of the drum in the discharge direction with the discharge gate fully open.

When truck mixer or truck agitator is used for transporting concrete that has been completely mixed in a stationary mixer, mixing during transportation shall be at

the speed designated by the manufacturer of the equipment as agitating speed.

When a truck mixer or agitator is used for transporting concrete, the concrete shall be delivered to the site of the work and discharge shall be completed within ninety (90) minutes after the introduction of the mixing water to the cement and aggregates, or the introduction of the cement to the aggregates. In hot weather, or under conditions contributing to quick stiffening of the concrete as determined by the Engineer, a delivery time of less than ninety (90) minutes may be required. When a truck mixer is used for the complete mixing of the concrete the mixing operations shall begin within thirty (30) minutes after the cement has been intermingled with the aggregate.

If the mixing plant is such a distance from the site of the work that it is not practical to have the mixed concrete delivered and placed in forms within the time limit specified, cement and water shall not be added until such time requirement can be complied with.

The organization supplying concrete shall have sufficient plant capacity and transporting apparatus to insure continuous delivery at the rate required. The rate of delivery of concrete shall be such as to provide for the proper handling and placing of concrete. An interval of more than forty-five (45) minutes between any two consecutive batches or loads, or a delivery and placing rate of less than eight (8) cubic yards of concrete per hour shall constitute cause for shutting down work for the remainder of the day, and if so ordered by the Engineer, the Contractor shall make, at his own expense, a construction joint at the location and of the type directed by the Engineer in the concrete already placed.

After mixing of ready-mixed concrete has been completed it shall be agitated continuously at agitating speed until it has been discharged from the drum.

Concrete manufactured by any procedure which results in any unmixed lumps of cement in the mixed product shall be rejected.

A ticket system shall be used for recording the transportation and delivery of batches from the plant to the

site of the work. The tickets will be issued by a State inspector to the truck operator at the plant for each load. The tickets shall be delivered to the inspector at the site of the work. Loads which do not carry such tickets or which do not arrive in satisfactory condition shall not be used in the work.

501.03.07 Hand Mixing. Hand mixing shall not be permitted, except in case of an emergency or under written permission of the Engineer. When permitted, it shall be done only on watertight platforms. The sand shall be spread evenly over the platform and the cement spread upon it. The sand and cement shall then be thoroughly mixed while dry by means of shovels until the mixture is of uniform color, after which it shall be formed into a "crater" and water added in the amount necessary to produce mortar of the proper consistency. The material upon the outer portion of the "crater" ring shall then be shoveled to the center and the entire mass turned and sliced until a uniform consistency is produced. The coarse aggregate shall then be thoroughly wetted and added to the mortar and the entire mass turned and re-turned at least six times and until all of the stone particles are thoroughly covered with mortar and the mixture is of a uniform color and appearance. Hand mixing will not be permitted for concrete to be placed under water.

501.03.08 Retempering. Concrete shall be mixed only in such quantities as are required for immediate use and shall be placed before initial set has taken place. Any concrete in which initial set has begun shall be wasted and not used in the work. No retempering of concrete shall be allowed.

501.03.09 Curing. (a) General. All concrete shall be cured for the length of time hereinafter specified. If Type III cement is used, the curing time may be reduced as directed by the Engineer. In the event of low temperatures, the time will be increased according to the procedure specified in subsection 501.03.10(b), "Cold Weather."

Curing shall commence immediately upon completion of the finish. In the event that the application or placement of the curing medium is delayed, curing will be as described under (b) below.

(b) Water Method. The concrete shall be kept continuously wet by the application of water for a minimum period of seven (7) days after the concrete has been placed.

The entire surface of the concrete shall be kept damp by applying water in the form of a fine fog mist, until the surface of the concrete is covered with the curing medium. The moisture from the nozzle shall not be applied under pressure directly upon the concrete and shall not be allowed to accumulate on the concrete in a quantity sufficient to cause a flow or wash the surface.

Cotton mats, rugs, carpets, or earth or sand blankets may be used as a curing medium to retain the moisture during the curing period. The cotton mats, rugs, or carpets shall be of such character that they will retain water.

(c) Curing Compound Method. The entire surface of the concrete shall be sprayed uniformly with a curing compound. It shall be applied when just a light film of water is present on the surface. If the surface is dry, water shall be added as specified in (b) above before the curing compound is applied.

On decks or slabs cured by this method, foot traffic must be held to a minimum and these surfaces shall not be used as a work area during the cure period. Should the film of the compound be damaged before the expiration of seven (7) days, the damaged portions shall be repaired immediately with additional compound.

This method shall not be used on surfaces until all finishing is completed.

The curing compound shall be delivered to the work in ready-mixed form. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. The compound shall not be diluted or altered in any manner, unless dilution is recommended by the manufacturer.

Curing compound that has become chilled to such an

extent that it is too viscous for satisfactory application shall be warmed to a temperature not exceeding one hundred (100) degrees Fahrenheit.

The curing compound shall be applied to the exposed surface at a uniform rate of one (1) gallon per one hundred fifty (150) square feet of area.

(d) Waterproof Paper. The membrane shall be formed into sheets of such width as to provide a complete cover of the entire concrete surface. All joints in the sheets shall be securely cemented together in such a manner as to provide a waterproof joint. Overlap of sheets shall have a minimum lap of eighteen (18) inches. The sheets shall be securely weighted down by placing a bank of earth on the edges of the sheets or by other means satisfactory to the Engineer.

The curing membrane shall remain in place for a period of not less than seven (7) days.

Should any portion of the sheets be broken or damaged before the expiration of the curing period, the broken or damaged portion shall be immediately repaired with new sheets properly cemented into place, or water curing as described above shall commence immediately. Sections of the membrane shall not be used which have lost their waterproof qualities or have been damaged to such an extent as to render them unfit for curing.

(e) Form Method. If forms are kept on concrete surfaces, this will be considered adequate cure for these surfaces. However, should the forms be removed within seven (7) days after the concrete has been placed, one of the above methods must be used on the exposed surfaces.

Attention is directed to subsection 502.03.12, "Removal of Falsework, Forms, and Housing."

501.03.10 Weather Limitations. (a) General. Concrete placement will not be permitted when in the opinion of the Engineer, impending weather conditions may result in rain, snow, or low temperatures which will impair the quality of the finished work. In case rainfall should occur after placing operations are started, the Contractor shall

provide ample covering to protect the work. The placing of concrete shall be stopped before the quantity of rainfall is sufficient to cause a flow or to wash the surface. If required by the Engineer, before any concrete is allowed to be placed, the contractor shall have adequate provisions on hand to protect the concrete from any impending weather conditions. In no case shall the Contractor be relieved of the responsibility of obtaining satisfactory work regardless of the weather.

Upon written notice from the Engineer, all concrete which has become damaged shall be replaced by the Contractor at his expense.

(b) Cold Weather—General. When it is necessary to place concrete at or below an atmospheric temperature of thirty-five (35) degrees Fahrenheit, or whenever in the opinion o fthe Engineer the temperature may fall below thirty-five (35) degrees Fahrenheit within the placing period, the water, aggregates or both shall be heated. Suitable enclosures and heating devices shall be provided to maintain the concrete surface temperatures above forty (40) degrees Fahrenheit for seven (7) days.

When aggregates or water must be heated, the concrete shall have a temperature of at least fifty (50) degrees Fahrenheit and not more than ninety (90) degrees Fahrenheit at the time of placing. Heating equipment or methods which alter or prevent the entrainment of the required amount of air in the concrete shall not be used. The equipment shall be capable of heating the materials uniformly. Aggregates and water used for mixing shall not be heated to a temperature exceeding one hundred fifty (150) degrees Fahrenheit. Materials containing frost or lumps of frozen material shall not be used.

Stockpiled aggregates may be heated by the use of dry heat or steam. Aggregates shall not be heated directly by gas or oil flame or on sheet metal over fire.

When aggregates are heated in bins, steam-coil or water-coil heating, or other methods which will not be detrimental to the aggregates may be used. The use of live steam on or through binned aggregates will not be permitted.

Concrete shall not be placed upon frozen ground or on any other object having a temperature of thirty-two (32) degrees Fahrenheit or below.

When concrete is to be placed in contact with cold reinforcing steel or previously placed concrete, measures shall be taken to raise the temperature of the steel and concrete to approximately fifty (50) degrees Fahrenheit before concreting shall begin.

After the concrete has been placed, means shall be taken to protect the concrete from any impending low temperatures. In case of low temperatures, any time limit required for curing, form and falsework removal, and applying live loads shall be increased one (1) day for every day that the minimum temperature of the surface of the concrete drops below fifty (50) degrees Fahrenheit. Holes shall be drilled in the forms where required by the Engineer, and thermometers inserted, to determine the temperature of the concrete.

(c) Low Temperature Protections—Insulating Blankets. Insulating blankets used to protect concrete from low temperatures shall be completely enclosed in liners bonded to both sides of the insulating mat. The liners shall have an extension on each side to form a flange so the blanket can be applied to the framework of the form. This cover must be fastened securely along the edges with enough overlap at joints of the blankets to insure that no opening will exist in the protection due to high winds or other adverse conditions. Provisions must be made to allow the reading of any thermometers placed inside of the protection. When depositing concrete against previously cast concrete, the blanket insulation shall extend at least fourteen (14) inches onto the existing concrete and securely held in place.

The above method shall be continued for a minimum of seven (7) days, during which time the temperatures of the concrete shall not be allowed to fall below forty (40) degrees Fahrenheit.

(d) Low Temperature Protection—Heating and Housing. In order to meet the provisions of articles (a) and (b) of this subsection, the concrete may be protected by

applying artificial heat within an enclosure. The enclosure shall be built with fire resistant material as far as practicable. The heating system shall be so arranged as to provide uniform heating, insuring that the concrete farthest from the source of heat is receiving adequate protection.

The above method shall be continued for a minimum of seven (7) days, during which time the temperatures of the concrete shall not be allowed to fall below forty (40) degrees Fahrenheit.

(e) Removal of Protection. In removing low temperature protection, the fall in temperature of the concrete surface shall not exceed twenty (20) degrees Fahrenheit in twenty-four (24) hours.

(f) Hot Weather. When atmospheric conditions (temperature, humidity, and wind) are such that rapid evaporation of mixing water from the concrete is likely to occur, the Contractor shall furnish and apply water to the concrete in the form of a fine fog mist. The water shall be applied in sufficient quantity as necessary to curb the harmful effects which would result from rapid drying out of the concrete and to cool the concrete.

BASIS OF PAYMENT

501.05.01 Payment. Portland cement concrete will be measured and paid for in accordance with the provisions specified in the various sections of these specifications covering construction requiring concrete.

SECTION 502

CONCRETE STRUCTURES

DESCRIPTION

502.01.01 General. This work shall consist of furnishing and placing Portland cement concrete in bridges, culverts, headwalls, retaining walls, and all other types of concrete structures. The concrete structures shall be constructed to the lines and grades given by the Engineer and in accordance with the design shown on the plans; the concrete shall be of the class or classes of concrete designated in the proposal and on the plans and shall conform to the requirements of Section 501, "Portland Cement Concrete." Unless otherwise specified, Class AA concrete shall be used.

MATERIALS

502.02.01 General. The materials used shall be those prescribed for the several items which constitute the finished work and shall conform to the requirements for such materials in the following sections:

Portland Cement Concrete	Section 501
Concrete Curing Materials and Admixtures	Section 702
Joint Materials	Section 707
Reinforcement	Section 713
Miscellaneous Metals	Section 712

Type II "low alkali" cement shall be used in all concrete structures, unless otherwise specified.

CONSTRUCTION

502.03.01 Depth of Footings. The elevation of the bottoms of footings, as shown on the plans, shall be considered as approximate only and the Engineer may order, in writing, such changes in dimensions or elevations of footings as may be necessary to secure a satisfactory foundation.

502.03.02 Forms. All forms shall be built mortar tight and of sufficient rigidity to prevent distortion due to the pressure of the concrete and other loads incidental to

the construction operations. Forms previously used shall be thoroughly cleaned of all dirt, mortar, and foreign matter before being reused. Before concrete is poured in forms all inside surfaces of the forms shall be thoroughly coated with an approved coating or form oil. Coating or form oil shall leave no film on the surface of the form that can be absorbed by the concrete. When required by the Engineer and immediately before placing concrete, the forms shall be thoroughly wetted with water.

When requested by the Engineer, the Contractor shall submit detailed plans of form work for examination by the Engineer. If such plans are not satisfactory to the Engineer, the Contractor shall make such changes as may be required, but it is understood that the Engineer's concurrence in the use of the plans as submitted or corrected shall in no way relieve the Contractor of responsibility in obtaining satisfactory results.

The forms shall be substantial and unyielding and shall be so designed that the finished concrete will conform to the proper dimensions and contours. The design of the forms shall take into account the effect of vibration on the concrete as it is placed.

Forms shall be filleted at all exposed corners unless corners are rounded as hereinafter provided. Triangular molding used for fillets shall have two (2) equal sides. In general, the width of the equal sides of moldings shall be three-fourths (¾) inch; for massive work, such as heavy pier copings and columns, the width shall be one and one-half (1½) to two (2) inches. Top edges of walls may be filleted or rounded as hereinafter provided for curbs. Top edges of curbs and slaps shall be rounded with an edging tool to a radius of one-half (½) to three-fourths (¾) inch.

When concrete is placed in excavation, forms shall be provided for all vertical surfaces unless otherwise permitted by the Engineer. On thin walls, such as abutments, wing walls, and retaining walls, the forms on one face shall be built up as the concrete is poured, but only to such elevation as will permit proper placing and thorough spading, and in no case greater than the height which can be

placed in one day's run. Ports shall be provided in high, thin walls to permit thorough cleaning before placing concrete.

If the forms develop any defects, such as bulging or sagging, after the concrete has been poured, that portion of the work shall be corrected in a manner satisfactory to the Engineer, without additional compensation to the Contractor.

During the erection and after the completion of the forms, they shall be protected in such manner as to preclude shrinkage, warping, curling, and distortion. Form lumber used a second time shall be free from bulge or warp and shall be thoroughly cleaned.

Forms for concrete over or in the vicinity of operating railroads shall be so constructed and placed that standard clearances demanded by the railroad company will be maintained at all times.

The falsework and forms supporting the bottom slab of the superstructure of box girder structures shall remain in place until the curing period of the deck of the superstructure has expired. Unless otherwise permitted by the Engineer, forms for the webs of box girders shall be removed before the deck slab is poured. All interior forms in box girders, except those permitted to remain in place, shall be completely removed and the inside of the box girder cleared of all loose material and swept clean.

Side forms for beams, girders, columns, railing, or other members of the structure wherein the forms do not resist dead load bending may be removed within a period from two (2) hours to seven (7) days as permitted by the Engineer, provided that satisfactory arrangements are made for curing and protecting the concrete thus exposed.

The side forms for arch rings, columns and piers shall be removed before the members of the structure which they support are poured or placed, so that the quality of the concrete may be inspected. All such side forms shall be so constructed that they may be removed without disturbing other forms which resist direct load or bending stresses.

The condition of the forms will have a direct bearing upon the amount of finishing required.

Full pieces of forms shall be used and shall extend from the bottom to the top of the wall or post.

Curved surfaces shall be formed to provide a smooth surface without visible breaks.

The forms shall be so constructed that portions, where finishing is required, may be removed without disturbing portions of forms to remain.

Forms shall be of sufficient strength to carry the dead weight of the concrete as a liquid without a deflection, in excess of $\frac{L}{270}$, and if such deflection occurs, it shall be sufficient cause for rejection of the work.

Forms for girders and slabs shall be cambered in such amount as may be required by the Engineer.

Approved form clamps or bolts shall be used to fasten forms. The use of ties consisting of twisted wire loops to hold forms in position during the placing of concrete will not be permitted.

Bolts or form clamps shall be positive in action and shall be of sufficient strength and number to prevent spreading of the forms. They shall be of such type that they can be entirely removed or cut back sufficiently to allow finishing of the concrete. All forms for the outside surfaces shall be constructed with stiff wales at right angles to the studs and all form clamps shall extend through and fasten such wales.

Plywood for forms shall be "exterior type" of the grade Concrete-Form Exterior, conforming to the specifications of the U.S. Department of Transportation, National Bureau of Standards, Commercial Standards, latest edition. Plywood form panels shall be furnished and placed in four (4) foot widths and in uniform lengths of not less than eight (8) feet, except where the dimensions of the member form are less than the specified panel dimensions. Where form panels are attached directly to the studding or joists, the panel shall not be less than five-eighths (⅝) inch thick. Form panels less than five-eighths (⅝) inch thick, otherwise conforming to the requirement herein

specified, may be used with continuous backing of one (1) inch nominal thickness surfaced material. All form panels shall be placed in a neat symmetrical pattern subject to the approval of the Engineer. The panel shall be placed with the long dimension perpendicular to the studs.

Approved corrugated metal forms may be used for the structural slab, provided the specified cover for the reinforcing steel is maintained above the crest of the corrugation. When the decision is made by the Contractor to use corrugated metal forms, the additional structural concrete required by their use shall be provided at his expense.

502.03.03 Falsework. Detailed plans of the falsework or centering shall be furnished by the Contractor to the Engineer in accordance with subsection 105.02, "Plans and Working Drawings" for any structures having a clear cast-in-place span of twenty (20) feet or over or any cast-in-place structure over traffic. If such plans are not satisfactory to the Engineer, the Contractor shall make such changes in them as may be required.

All falsework or centering shall be designed and constructed to provide the necessary rigidity and to support the loads. Falsework for the support of superstructures for box girder spans shall be designed to support the loads that would be superimposed were the entire superstructure poured at one time.

For designing falsework and centering, a weight of one hundred fifty (150) pounds per cubic foot shall be assumed for green concrete (one hundred twenty (120) pounds for lightweight concrete) and an allowance of not less than twenty-five (25) pounds per cubic foot for forms, live load, and impact. Falsework or forms shall be constructed to produce in the finished structure the lines and grades indicated on the plans. Suitable screw jacks or wedges in pairs shall be used in connection with falsework or centering to set the forms to grade or cambered as shown on the plans, or to take up any settlement in the form work either before or during the placing of concrete. Excessive use of blocking and shims shall be cause for rejection of the falsework. Falsework failures shall become the sole responsibility of the Contractor.

Immediately prior to placing bridge deck or slab concrete, the Contractor shall check all falsework and wedges or jacks and shall make all necessary adjustments. Care shall be exercised to insure that settlement and deflection due to the added weight of the deck or slab concrete will be a minimum. Suitable means such as telltales shall be provided by the Contractor to permit ready measurement of settlement and deflection as it occurs.

Falsework or centering shall be founded on a solid footing safe from undermining and protected from softening. Falsework which cannot be founded on a satisfactory footing shall be supported on piling which will be spaced, driven, and removed in a manner approved by the Engineer.

Arch span shall be removed uniformly and gradually beginning at the crown and working toward the spring, to permit the arch to take its load slowly and evenly. Centering for bridges having two or more adjacent arch spans shall be struck simultaneously.

502.03.04 Reinforcement. Reinforcing shall be furnished and placed as shown on the plans and in accordance with the applicable provisions of Section 505, "Reinforcing Steel" of these specifications.

502.03.05 Cofferdams and Cribs. Cofferdams for foundation construction shall be carried well below the bottom of the footings and shall be well braced and as watertight as practical. The interior dimensions of cofferdams shall be such as to provide sufficient clearance for constructing forms and, when no seal is placed, to permit pumping outside the forms.

The Contractor shall submit for approval, drawings showing proposed method of construction of cofferdams or cribs in accordance with subsection 105.02, "Plans and Working Drawings." Approval of such drawings shall in no way relieve the Contractor of his responsibility under the contract for the successful completion of the improvement. Cofferdam construction shall not start before the submitted drawings are approved and returned.

After the completion of the substructure, the cofferdams with all sheeting and bracing shall be removed to one (1) foot below the stream bed, by the Contractor, and such removal shall be performed in such a manner as not to disturb or mar the finished concrete foundation. Removal of cofferdams, sheeting, and bracing shall be considered subsidiary to other pay items of work and no further payment will be made therefor.

502.03.06 Pumping Water. Pumping from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of the movement of water through any fresh concrete. No pumping will be permitted during the placing of concrete or for a period of at least twenty-four (24) hours thereafter, unless it be done from a suitable pump separated from the concrete work by a watertight wall or other effective means.

Pumping to unwater a sealed cofferdam shall not commence until the seal has set sufficiently to withstand the hydrostatic pressure.

502.03.07 Mixing Concrete. All concrete shall be mixed and proportioned as specified in Section 501, "Portland Cement Concrete."

502.03.08 Handling and Placing Concrete. (a) General. In preparation for the placing of concrete, all sawdust, chips, and other construction debris and extraneous matter shall be removed from the interior of forms. Struts, stays, and braces, serving temporarily to hold the forms in correct shape and alignment, pending the placing of concrete at their locations, shall be removed when the concrete placing has reached an elevation rendering their service unnecessary. These temporary members shall be entirely removed from the forms and not buried in the concrete.

No concrete shall be used which does not reach its final position in the forms within the time stipulated under Section 501, "Portland Cement Concrete."

Surfaces on which concrete is to be placed shall be

thoroughly moistened with water immediately before placing concrete.

Concrete shall be placed so as to avoid segregation of the material and the displacement of the reinforcement. The use of long troughs, chutes, and pipes for conveying concrete from the mixer to the forms shall be permitted, only on written authorization of the Engineer. In case an inferior quality of concrete is produced by the use of such conveyors, the Engineer may order discontinuance of their use and the substitution of a satisfactory method of placing.

Open troughs and chutes shall be of metal or metal lined; where steep slopes are required, the chutes shall be equipped with baffles or be in short lengths that reverse the direction of movement.

All chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run; water used for flushing shall be discharged clear of the structure.

When placing operations would involve dropping the concrete more than five (5) feet, it shall be deposited through sheet metal or other approved pipes, except when placing concrete for thin vertical walls less than fifteen (15) inches thick, double belting may be used in lieu of adjustable pipes or elephant trunks. As far as practicable, the pipes shall be kept full of concrete during placing and their lower ends shall be kept buried in the newly placed concrete. After initial set of the concrete, the forms shall not be jarred and no strain shall be placed on the ends of reinforcement bars which project.

All concrete placed in concrete structures, except tremie seal concrete, shall be compacted by means of mechanical vibration subject to the following provisions:

1. The number of vibrators employed shall be ample to consolidate incoming concrete to a proper degree within fifteen (15) minutes after it is deposited in the forms. In all cases, at least two vibrators shall be available at the site of the structures in which more than twenty-five (25) cubic yards is being placed.

2. The vibration shall be internal unless special authorization of other methods is given by the Engineer or as provided herein.

3. Vibrators shall be capable of transmitting vibration to the concrete at frequencies of not less than 4,500 impulses per minute.

4. The intensity of vibration shall be such as to visibly affect a mass of concrete of one (1) inch slump over a radius of at least eighteen (18) inches.

5. Vibrators shall be manipulated so as to thoroughly work the concrete around the reinforcement and imbedded fixtures and into the corners and angles of the forms.

Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete. The vibrators shall be inserted and withdrawn out of the concrete slowly. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete, but shall not be continued at any one point to the extent that localized areas of grout are formed.

Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective.

6. Vibration shall not be applied directly or through the reinforcement to sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibration. It shall not be used to make concrete flow in the forms over distances so great as to cause segregation, and vibrators shall not be used to transport concrete in the forms.

7. Vibration shall be supplemented by such spading as is necessary to insure smooth surfaces and dense concrete, along form surfaces and in corners and locations impossible to reach with the vibrators.

8. The provisions of this article shall apply to the filler concrete for steel grid floor except that the vibrator shall be applied to the steel.

Immediately following the discontinuance of placing concrete, all accumulations of mortar splashed upon the reinforcement steel and the surfaces of forms shall be removed. Dried mortar chips and dust shall not be puddled into the unset concrete. If the accumulations are not removed prior to the concrete becoming set, care shall be

exercised not to injure or break the concrete-steel bond at and near the surface of the concrete while cleaning the reinforcement steel.

(b) Culverts. In general, the base slab or footings of box culverts shall be placed and allowed to set before the remainder of the culvert is constructed. In this case, suitable provision shall be made for bonding the sidewalls to the culvert base.

Before concrete is placed in the sidewalls, the culvert footing shall be thoroughly cleaned of all shavings, sticks, sawdust, or other extraneous material and the surface carefully chipped and roughened in accordance with the method of bonding construction joints as specified herein.

Walls and top slab shall not be constructed as a monolith on box culverts where the depth of pour below the bottom of the top slab exceeds four (4) feet. When this method of construction is used any necessary construction joints shall be vertical and at right angles to the axis of the culvert.

When walls are poured separately, in non-rigid frame box culverts, the concrete in the walls shall be placed and allowed to set a minimum of two (2) hours before the top slab is placed.

When walls are poured separately, in rigid frame box culverts, the concrete in the walls shall be placed and allowed to set a minimum of twelve (12) hours before the top slab is placed.

Each wing wall shall be constructed, if possible, as a monolith. Construction joints, where unavoidable, shall be horizontal and so located that no joint will be visible in the exposed face of the wing wall above the ground line.

(c) Girders, Slabs, and Columns. When the height of any point of web is more than three (3) feet from the bottom of the top slab to bottom of the web for "T" beams, or to construction joint for box girders, the top slab shall be poured independent of webs.

Concrete in slab spans shall be placed in one continuous operation for each span unless otherwise specified.

Concrete in columns shall be placed in one continuous operation, unless otherwise specified. The concrete shall

be allowed to set at least twelve (12) hours before the succeeding pour is started.

Before pouring concete for superstructure, the forms on base of columns shall be exposed sufficiently to determine the character of the concrete in the columns.

502.03.09 Pumping Concrete. Placement of concrete by pumping will not be permitted unless authorized in writing by the Engineer. The equipment shall be so arranged that no vibrations result which might damage freshly placed concrete.

Where concrete is conveyed and placed by mechanically applied pressure the equipment shall be suitable in kind and adequate in capacity for the work. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients. After this operation, the entire equipment shall be thoroughly cleaned.

502.03.10 Concrete Deposited Under Water. If conditions render it impossible or inadvisable, in the opinion of the Engineer, to dewater excavations before placing concrete, the Contractor shall deposit under water, by means of a tremie or underwater bottom dump bucket, a seal course of concrete of sufficient thickness to thoroughly seal the cofferdam. The concrete shall be carefully placed in a compact mass and shall not be disturbed after being deposited. Still water shall be maintained at the point of deposit.

A tremie shall consist of a watertight tube having a diameter of not less than ten (10) inches with a hopper at the top. The tube shall be equipped with a device that will prevent water from entering the tube while charging the tube with concrete. The tremie shall be supported so as to permit free movement of the discharge end over the entire top surface of the work and to permit rapid lowering, when necessary to retard or stop the flow of concrete.

The tremie shall be filled by a method that will prevent washing of the concrete. The discharge end shall be completely submerged in concrete at all times and the tremie tube shall contain sufficient concrete to prevent any water entry. When a batch is dumped into the hopper, the flow of concrete shall be induced by slightly raising the discharge end, always keeping it in the deposited concrete. The flow shall be continuous until the work is completed and the resulting concrete seal shall be monolithic and homogeneous.

The underwater bucket shall have an open top and the bottom doors shall open freely and outward when tripped. The bucket shall be completely filled and slowly lowered to avoid backwash and shall not be dumped until it rests on the surface upon which the concrete is to be deposited. After discharge, the bucket shall be raised slowly until well above the concrete.

Concrete deposited in water shall be Class A or Class AA with ten (10) percent extra cement added. The exact thickness of the seal will depend upon the hydrostatic head, bond and spacing of piles, size of cofferdam, and other related factors, but in no case shall the seal be less than two (2) feet in thickness, unless otherwise shown on the plans. Before dewatering, the concrete in the seal shall be allowed to cure for not less than five (5) days after placing.

If a seal which is to withstand hydrostatic pressure is placed in water having a temperature below forty-five (45) degrees Fahrenheit, the curing time before dewatering shall be increased. Periods of time during which the temperature of the water has been continuously below thirty-eight (38) degrees Fahrenheit shall not be considered as curing time. After sufficient time has elapsed to insure adequate strength in the concrete seal, the cofferdam shall be dewatered and the top of the concrete cleaned of all scum, laitance, and sediment. Before fresh concrete is deposited, local high spots shall be removed as necessary to provide proper clearance for reinforcing steel.

502.03.11 Construction Joints. Construction joints shall be made only where located on the plans or shown

in the pouring schedule, unless otherwise approved by the Engineer.

Construction joints where the placing of concrete is delayed until the concrete has taken its initial set and for which no expansion is provided, shall be planned in advance and shall be subject to approval by the Engineer. The placing of concrete shall be continuous from joint to joint. These joints shall be perpendicular to the principal lines of stress and, in general, located at points of minimum shear. Only joints shown on the plans will be permitted in a cantilevered member. Horizontal joints at piers and abutments, except where specified, shall generally be avoided, and when used shall not be located within two (2) feet of the normal water level.

Unless otherwise specified, construction joints shall be struck off but not troweled.

When making a horizontal construction joint, care shall be taken to have the concrete as dry as possible, and any excess water or creamy material shall be drawn off before the concrete sets. On all exposed surfaces, the line of the proposed joint shall be made truly straight by taking a temporary straightedge on the inside of the form and pouring the concrete so that it will set flush with the edge as provided.

To avoid visible joints as far as possible upon exposed faces the top surfaces of the concrete adjacent to the forms shall be smoothed with a trowel. Where a "feather edge" might be produced at a construction joint, as in the sloped top surface of a wing wall, an insert form work shall be used to produce a blocked out portion in the preceding layer which shall produce an edge thickness of not less than six (6) inches in the succeeding layer.

When the work is unexpectedly interrupted by breakdowns, storm, or other causes, and the concrete as placed would produce an improper construction joint, the Contractor shall either rearrange the freshly deposited concrete, or continue by hand mixing, if necessary, until a suitable arrangement is made for a construction joint. When such a joint occurs at a section on which there is shearing stress, he shall provide adequate mechanical bond

across the joint by inserting reinforcing steel, or by some other means satisfactory to the Engineer, which will prevent a plane of weakness.

In resuming work, the surface of the concrete previously placed shall be thoroughly cleaned of dirt, scum, laitance, or other soft or porous materials by one of the following methods:

(a) Concrete surface of fresh concrete (not more than eight (8) hours after placement) shall be cleaned with air and water jets in such a manner that the surface is thoroughly cleaned and the aggregate is not loosened.

(b) Hardened concrete surface (more than eight (8) hours after placement) shall be cleaned by abrasive blast methods in such a manner that the aggregate is not loosened or the edges of the concrete shattered.

The surface of the joint shall be thoroughly washed with clean water and the forms tightened to close contact with the previously placed work, after which the concreting may proceed. The surface of the joint shall be wet just prior to placing new concrete.

502.03.12 Removal of Falsework, Forms, and Housing. In the determination of the time for the removal of falsework, forms, and housing, and in the discontinuance of heating, consideration shall be given to the location and character of the structure, the weather and other conditions influencing the setting of the concrete, and the materials used in the mix.

Falsework or forms shall not be removed where stresses will be placed on the concrete until the concrete has reached the following minimum compressive strength (psi) or time requirements:

Arch centers	2,400 lbs.
Centering under beams and girders	2,400 lbs.
Floor slabs	2,400 lbs.
Columns	24 hrs. min.
Walls	12–24 hrs.
Parapets and curbs	2–12 hrs.
Sides of beams, girders, and all other parts	12–24 hrs.

Attention is directed to subsection 501.03.09, "Curing."

Compressive strengths will be determined by Test Method No. Nev. T475 and will be considered information tests only and not acceptance tests as described in subsection 501.02.04, "Concrete Making Properties."

Method of form removal likely to cause overstressing of the concrete shall not be used. Forms and their supports shall not be removed without the approval of the Engineer. Supports shall be removed in such a manner as to permit the concrete to uniformly and gradually take the stresses due to its own weight.

502.03.13 Expansion and Fixed Joints and Bearings. All joints shall be constructed according to details shown on the plans.

(a) Open Joints. Open joints shall be placed in the locations shown on the plans and shall be constructed by the insertion and subsequent removal of a wood strip, metal plate, or other approved material. The insertion and removal of the template shall be accomplished without chipping or breaking the corners of the concrete. Reinforcement shall not extend across an open joint unless so specified on the plans.

(b) Filled Joints. Poured expansion joints shall be constructed similar to open joints. When premolded types are specified, the filler shall be placed in correct position as the concrete on one side of the joint is placed. When the form is removed, the concrete on the other side shall be placed.

(c) Steel Joints. The plates, angles, or other structural shapes shall be accurately shaped, at the shop, to conform to the section of the concrete floor. The fabrication and painting shall conform to the requirements of these specifications covering those items. When called for on the plans or in the special provisions the materials shall be galvanized in lieu of painting. Care shall be taken to insure that the surface in the finished plane is true and free of warping. Positive methods shall be employed in placing the joints to keep them in correct position during the placing of the concrete. The opening at expansion

joints shall be that designated on the plans at normal temperature, and care shall be taken to avoid impairment of the clearance in any manner.

(d) Waterstops. Waterstops shall be furnished and installed in accordance with the details shown on the plans.

Waterstops shall be manufactured from either natural rubber, synthetic rubber, or polyvinyl chloride (PVC), at the option of the Contractor.

Waterstops shall be manufactured with an integral cross section which shall be uniform within $\pm$ $\frac{1}{8}$ inch in width, and the web thickness or bulb diameter, within $+$ $\frac{1}{16}$ inch and $-$ $\frac{1}{32}$ inch. No splices will be permitted in straight strips. Strips and special connections pieces shall be well cured in a manner such that any cross section shall be dense, homogeneous, and free from all porosity. All junctions in the special connection pieces shall be full molded. During the vulcanizing period the joint shall be securely held by suitable clamps. The material at the splices shall be dense and homogeneous throughout the cross section.

Field splices for either natural or synthetic rubber waterstops shall be either vulcanized; mechanical, using stainless steel parts; or made with a rubber splicing union of the same stock as the waterstop, at the option of the Contractor. All finished splices shall have a full size tensile strength of $600 \frac{\text{(width in inches)}}{6}$ pounds.

Field splices for polyvinyl chloride waterstops shall be formed by heat sealing the adjacent surfaces in accordance with the manufacturer's recommendations. A thermostatically controlled electric source of heat shall be used to make all splices. The heat shall be sufficient to melt but not char the plastic.

Waterstops, when being installed, shall be cut and spliced at changes in direction as may be necessary to avoid buckling or distortion of the web or flange.

(e) Bearing Devices. Bearing plates, bars, rockers, assemblies, and other expansion or fixed devices shall be

constructed in accordance with the details shown on the plans and shall be hot-dip galvanized after fabrication in accordance with Section 715, "Galvanizing." Structural steel and cast steel shall conform to the provisions in Section 506, "Steel Structures," for those items.

The bearing plates shall be set level and the rockers or other expansion devices shall be set to conform to the temperature at the time of erection or to the setting specified.

When bearing assemblies or masonry plates are shown on the plans to be placed (not embedded) directly on concrete, the concrete bearing area shall be constructed slightly above grade and shall be finished by grinding or other approved means to a true level plane which shall not vary perceptibly from a straightedge placed in any direction across the area. The finished plane shall not vary more than one-eighth (⅛) inch from the elevation shown on the plans.

When elastomeric bearing pads, elastic bearing pads, preformed fabric pads, or asbestos sheet packing are shown on the plans, the concrete surfaces on which pads or packing are to be placed shall be wood float finished to a level plane which shall not vary more than one-sixteenth ($\frac{1}{16}$) inch from a straightedge placed in any direction across the area. The finished plane shall not vary more than one-eighth (⅛) inch from the elevation shown on the plans.

Where bearing assemblies or masonry plates are shown on the plans to be placed on grout pads, they shall be placed in accordance with the provisions in subsection 506.03.28, "Bearing and Anchorage."

(f) Elastomeric Bearing Pads. Pads over one (1) inch in thickness shall be laminated. Laminated pads shall consist of alternate laminations of elastomer and metal or elastomer and fabric bonded together.

Pads shall be installed where designated on the plans.

502.03.14 Curing. Curing of formed concrete shall conform to the requirements of subsection 501.03.09, "Curing," and attention is directed thereto.

502.03.15 Patching. After removal of forms, all metal ties except those to be used to aid future forming shall be cut back and patched. Honeycomb shall be removed and patched. When honeycomb is determined by the Engineer to be excessive, it shall be sufficient cause for rejection of all or a part of the structure.

Loose or broken material shall be chipped away until a dense, uniform surface exposing solid coarse aggregate is obtained. Feather edges shall be cut away to form a face perpendicular to the surface being patched. All surfaces of the cavity shall be thoroughly saturated with water. Contact surfaces shall be coated with an approved bonding agent. Bonding agent may be mixed with mortar in lieu of coating the contact surfaces.

Patching mortar shall consist of one part cement and three parts sand. White cement or other approved tinting materials shall be used on all surfaces where an "ordinary finish" is final. For patching large or deep areas, coarse aggregate shall be added to the patching mortar.

The patching mortar shall be thoroughly tamped into place. Mortar may be placed pneumatically when approved by the Engineer. The surface of the mortar shall be floated with a wooden float before initial set takes place. The patch shall present a neat and workmanlike appearance.

The patched surface shall be cured by one of the methods described in subsection 501.03.09, "Curing."

Patching is the only treatment required for those portions of the structure below ground.

502.03.16 Finish of Horizontal Surfaces. Concrete bridge decks shall be struck off with a template immediately after pouring to provide the proper crown and shall be finished to a smooth even surface by means of both longitudinal and transverse wooden floats, or other suitable means. When a transversely broomed finish is used, the allowable variations noted herein shall be independent of the depth of the broom marks. No variations will be permitted that will tend to prevent complete drainage on all parts of the deck. The surface shall be corrected by

grinding off the high spots, or other approved method, as may be required in order to conform to these limits. An edging tool shall be used at expansion joints and deck edges not armored.

502.03.17 Formed Surfaces Requiring Finishing. Structures requiring a "fine surface finish" (F.S.F.) will be noted on the plans. All structures not requiring a fine surface finish shall be given an ordinary surface finish. Only exposed surfaces of structures will require finishing (ordinary or fine).

Exposed surfaces are defined as follows:

(a) Exterior vertical faces of slab spans, rigid frames, arches, and box girders.

(b) The underside of overhanging slabs to point of junction of the supporting beams.

(c) Vertical surfaces of piers, columns, bent caps, abutments, wing walls, and retaining walls which are exposed to view after all backfill and embankment is placed. Exposed surfaces, in this case, are considered to extend to one (1) foot below finished grade.

(d) The inside of culvert barrels over four (4) feet in height for the same distance as the height of the opening when seen from a traveled way.

(e) The underside of superstructures in urban areas.

502.03.18 Ordinary Surface Finish. The surface shall have all holes left by form ties filled and all defects repaired in accordance with subsection 502.03.15, "Patching." The surface shall be true and even, free from stone pockets, depressions, or projections beyond the surface. A uniform color and appearance shall be obtained on all patched surfaces.

502.03.19 Fine Surface Finish. (a) General. Unless otherwise specified in the contract documents, the Contractor shall have the option of applying a "rubbed finish" or a "bonded finish" as provided hereinafter. However, all fine surface finishes on the project shall be applied by the one method chosen by the Contractor. Before a "rubbed

finish" or a "bonded finish" is applied, the surface shall be true and even, free from stone pockets, depressions, or projections beyond the surface. All fins and projections shall be knocked off or ground flush. Offsets greater than one-eighth (⅛) inch shall be filled or tapered back to present a smooth appearance. All holes one-fourth (¼) inch or more in largest diameter shall be patched in accordance with subsection 502.03.15, "Patching."

(b) Rubbed Finish. When the concrete has hardened before being rubbed, the surface shall be thoroughly saturated with water and rubbed with a medium coarse carborundum stone, using a small amount of mortar on its face. The mortar shall be composed of cement and fine sand mixed in the proportions used in the concrete being rubbed. When forms are removed while the concrete is still green the surface shall be wetted and rubbed with a wooden float. If permitted by the Engineer, a thin mortar proportioned as outlined above may be used in the rubbing.

Rubbing shall be continued until all form marks, projections, and irregulatrities have been removed, all voids filled and a uniform surface has been obtained. The paste produced by this rubbing shall be kept continuously moist for at least forty-eight (48) hours. The surface shall then be smoothed by rubbing with a fine carborundum stone and water. This rubbing shall be continued until the entire surface is of a smooth texture and uniform color. After the final rubbing is completed and the surface has dried, it shall be rubbed with burlap to remove loose powder and shall be left free from all unsound patches, paste, powder, and objectionable marks.

(c) Bonded Grout Finish. This finish shall be an application of grout consisting of sand, cement, water, coloring agent if required, and a bonding agent mixed with water, all mixed to the desired consistency. The texture desired is rather smooth with projections no larger than the largest nominal sand sizes. A texture with valleys and projections which give an appearance of being stuccoed or plastered will not be acceptable. The application of the grout must, in the sole opinion of the Engineer, present a uniform

appearance in color and texture equal to or better than that of the approved referee panel.

The bonding agent shall be composed of either epoxies, acrylics, vinyls, phenolics, or other approved resins. A quart sample, or larger, shall be submitted to the Engineer along with the manufacturer's recommendation for use with grout. The bonding agent shall not be used until written approval is given by the Engineer. Unless otherwise permitted, the manufacturer's recommendations will be strictly adhered to in regard to the bonding agent water ratio.

Grout shall consist of about three parts sand to one part cement. Final proportion to be determined after application on the referee panels. Sand shall be mortar size with one hundred (100) percent passing the No. 40 sieve. Portland cement shall be the same brand and type used in the structure. Coloring agents, that may be specified in the contract documents, shall not be used until approved by the Engineer.

The Contractor shall furnish one or more four by eight foot (4′ x 8′) concrete referee panels as necessary to obtain a referee panel with a finish satisfactory to the Engineer. Panels shall be prepared at least two (2) weeks before start of finishing and shall have a wood float finish. The referee panel shall be used as experimental section to determine the texture, coloring, appearance in general, and methods of application. The method of application, equipment used, mixture proportions, etc., shall be carefully recorded by the Contractor and used on the structures so that the finish on the structures will duplicate that on the accepted referee panel. The Contractor shall furnish the Engineer with a copy of such records prior to commencing finishing operations on the structures. The approved mixture, equipment, and method shall not be changed without permission of the Engineer.

The grout shall be brushed on, rolled on, or air-blown in a manner approved by the Engineer. The acceptable referee panel will be maintained and available for comparison until the fine finishing is complete. All referee panels shall be disposed of by the Contractor at the completion of the finishing work.

Surfaces treated with curing compounds shall be thoroughly cleaned by either: (1) an application of ten (10) to fifteen (15) percent muriatic acid wash which shall be so applied as to completely remove any oily film and to lightly etch the surface, after which the surface shall be thoroughly rinsed with clean water to remove all acid, or (2) thoroughly cleaned by approved abrasive means as may be required to remove all oily film, after which the surface shall be thoroughly rinsed with clean water.

The Contractor shall submit in writing to the Engineer, the bonding agent manufacturer's recommendations for equipment and methods used in the application of bonded grout. These recommendations shall be followed, with approved variations, in applying bonded grout to the referee panels.

The Contractor shall be careful in applying the mixture so that an overlap will not occur which may give a blotched or discolored effect.

The finish must adhere to the concrete surface such that it cannot be removed when rubbed with the bare hand after seven (7) days.

Equipment used in applying pneumatically sprayed grout shall be adequate to produce grout of uniform composition and consistency from the initial to the final discharge of the batch. The same equipment used on the selected referee panel shall be used in applying the grout. All equipment used must be demonstrated to be adequate for the purpose for which it is intended. For experimentation of surface texture, the Engineer may require different nozzle sizes and pressures to be used when applying the mixture to the referee panels.

502.03.20 Live Loads. Live loads such as traffic or superimposed earth loads shall not be allowed on the structure until concrete has reached an age of fourteen (14) days and it has reached a strength of three thousand (3,000) psi or the minimum twenty-eight (28) days' strength shown on the plans. Live loads may be allowed on

the structure when the concrete has reached an age of eight (8) days and a strength of three thousand (3,000) pounds per square inch in cases where Type III (high-early strength) cement is used with the approval of the Engineer.

The minimum days required before applying a live or superimposed load or removing forms shall be increased after the initial seven (7) days curing period in accordance with subsection 501.03.10(d), "Cold Weather—General."

In case the concrete does not reach the desired strength within the time specified, the Engineer shall determine when the strength is adequate to carry live loads.

METHOD OF MEASUREMENT

502.04.01 Measurement. The estimated quantity shown on the plans, plus or minus quantities covered by approved changes, will be the quantity used for payment. The Engineer or the Contractor may, however, request a final measurement. The Contractor's request for final measurement shall be in writing. Final measurement will be made according to the dimensions shown on the plans plus or minus approved changes and quantities derived therefrom will be the quantity used for payment. Each class of concrete will be considered separately. Only those quantities complete and in place will be measured for payment.

It is agreed by the parties to the contract that (a) in case Portland cement concrete of Class A, or AA, or D, or DA, does not conform to the twenty-eight (28) day compressive strength requirements of Table I of Section 501, damage will be sustained by the Department, and (b) it is extremely difficult to ascertain the actual damage which the Department will sustain; therefore, it is agreed that the Department will deduct from the Contractor as liquidated damages, money due or to become due the Contractor from the Department a percentage of the contract unit bid price as set forth in the following schedule:

28-Day Compressive Strength—PSI	Liquidated Damage—Per Unit Bid Price (percent)
3,000	0
2,999–2,950	2
2,949–2,900	6
2,899–2,850	12
2,849–2,800	21
2,799–2,750	33
2,749–2,700	47
2,699–2,650	64
2,649–2,600	82
2,599 or less	100

Concrete shown by test to have less than two thousand six hundred (2,600) psi compressive strength shall be removed and replaced, or at the option of the Engineer, may be left in place without payment.

No measurements or other allowances will be made for work, material for forms, falsework, cofferdams, pumping, bracing, etc.

The quantity of concrete involved in fillets, scorings, and chamfers two (2) square inches or less in cross sectional area shall be neglected. No deduction shall be made for the volume of concrete displaced by reinforcing steel, expansion joint material, drainage and weep holes, pipes, conduits, and ducts embedded in concrete. Deduction shall be made for the volume of timber piles, concrete piles, and cast-in-place piles embedded in the concrete.

Tremie seal concrete will be measured on the basis of batched volume placed.

The quantity of concrete hand rail to be measured for payment will be the number of linear feet complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

502.05.01 Payment. The accepted quantity of concrete measured as provided in subsection 502.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard for the Class or Type specified. Reinforcing steel will be paid for as provided in Section 505, "Reinforcing Steel." All metal parts, fabrics, pads, joint

filler, drains, referee panels for "Bonded Grout Finish," and any other materials not specifically mentioned for payment herein, will be considered subsidiary to the other pay items of the work and no further compensation will be allowed therefor.

The accepted quantity of concrete rail measured as provided in subsection 502.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Class (....) Concrete	Cubic Yard
Concrete Rail	Linear Foot
Tremie Seal Concrete	Cubic Yard

SECTION 503

PRECAST PRESTRESSED CONCRETE MEMBERS

DESCRIPTION

503.01.01 General. This work shall consist of furnishing and placing precast prestressed concrete members as specified in these specifications and the contract documents.

This work shall include the manufacture, transportation, and storage of girders, slabs, piling, and other structural members of precast prestressed concrete and shall also include the placing of all precast prestressed concrete members, except piling which shall be placed as provided in Section 508, "Piling."

The members shall be furnished complete including all concrete, prestressing steel, bar reinforcing steel and incidental materials in connection therewith.

MATERIALS

503.02.01 General. Concrete shall conform to the applicable requirements of Sections 501, "Portland Cement Concrete" and 502, "Concrete Structures." Prestressing steel shall conform to the applicable requirements of Section 713, "Reinforcement."

If lightweight concrete is used, it shall conform to the applicable requirements of Section 504, "Lightweight Concrete for Structures."

CONSTRUCTION

503.03.01 Prestressing Methods. Prestressing shall be performed by either pretensioning or post-tensioning methods. The method of prestressing to be used shall be optional with the Contractor, subject to the requirements specified in these specifications.

Prior to casting the precast members, the Contractor shall submit working drawings to the Engineer for approval giving complete details of the methods, materials and equipment he proposes to use in the prestressing and construction and erection operations. Such details shall

outline the method of prestressing, and shall include the arrangement of the prestressing steel and mild steel reinforcement in the members, anchoring stresses, sequence of stressing post-tensioned prestressing steel, and the sequence of cutting or releasing pretensioned prestressing steel, type of post-tensioning enclosures, and specifications and details of anchoring devices and distribution plates or assemblies, if required, for post-tensioning and pressure grouting materials and equipment, together with complete drawings of the forms proposed for casting the precast members. Such drawings shall show complete details of the type of forms proposed for providing the cored holes and proposed method of supporting and anchoring such forms.

Working drawings shall be in accordance with subsection 105.02, "Plans and Working Drawings."

503.03.02 Forms. Concrete shall not be deposited in the forms until the Engineer has inspected the placing of the reinforcement, enclosure, anchorages, and prestressing steel.

The concrete shall be vibrated internally or externally, or both, as required to consolidate the concrete. The vibrating shall be done with care and in such a manner that displacement of reinforcement, enclosures, and prestressing steel will be avoided.

Holes for anchor bars, and for diaphragm dowels which pass through the member, openings for connection rods, recesses for grout, and holes for railing bolts shall be provided in the members in accordance with the details shown on the plans. Where diaphragm dowels do not pass through the member, the dowels may be anchored in the member by embedment in the concrete or by means of an approved threaded insert.

Forms for interior cells or holes in the members shall be constructed of a material that will resist breakage or deformation during the placing of concrete and will not materially increase the weight of the member.

Lifting anchors may be installed in members to be placed in bridge decks provided that all of the anchor above the concrete is removed after the member is placed.

Side forms for prestressed members may be removed the

next day after placing concrete therein, provided arrangements satisfactory to the Engineer are made for curing and protecting the concrete.

503.03.03 Anchorages and Distribution. All post-tensioned prestressing steel shall be secured at the ends by means of approved permanent type anchoring devices.

Anchorage devices shall hold the prestressing steel without slip of more than one-eighth (⅛) inch at a load of one hundred fifty (150) percent of the amount required for the initial stress. Steel distribution plates or assemblies for the distribution of the load from the anchorage devices shall be furnished and installed, except as hereinafter provided.

When headed wires are used, the outside edge of any hole for prestressing wire through a stressing washer or through an unthreaded bearing ring or plate shall not be less than one-fourth (¼) inch from the root of the thread of the washer or from the edge of the ring or plate.

The load from the anchoring device shall be distributed to the concrete by means of approved devices that will effectively distribute the load to the concrete.

Distribution plates or assemblies shall conform to the following requirements:

(a) The final unit compressive stress on the concrete directly underneath the plate or assembly shall not exceed three thousand (3,000) pounds per square inch.

(b) Bending stresses in the plates or assemblies induced by the pull of the prestressing steel shall not exceed the yield point of the material or cause visible distortion in the anchorage plate when one hundred (100) percent of the ultimate load is applied as determined by the Engineer.

(c) Materials and workmanship shall conform to the requirements in Section 506, "Steel Structures."

Should the Contractor elect to furnish anchoring devices of a type which are sufficiently large and which are used in conjunction with a steel grillage imbedded in the concrete that effectively distributes the compressive stresses to the concrete, the steel distribution plates or assemblies may be omitted.

Where the end of a post-tensioned assembly will not be

covered by concrete, the anchoring devices shall be recessed so that the ends of the prestressing steel and all parts of the anchoring devices will be at least two (2) inches inside of the end surface of the members, unless a greater embedment is shown on the plans. Following post-tensioning, the recesses shall be filled with grout, and finished flush. The grout shall conform to the requirements of subsection 706.03.04, "Grout and Mortar Sand," and shall consist of one part cement and two parts sand.

503.03.04 Enclosures. Enclosures for prestressing steel shall be ferrous metal, mortar-tight, and accurately placed at the locations shown on the plans or approved by the Engineer.

In lieu of metallic enclosures, openings for prestressing steel may be formed by means of cores or ducts composed of rubber or other suitable materials which are removed prior to installing prestressing steel.

All enclosures or openings of anchorage assemblies shall be provided with pipes or other suitable connections for the injection of grout after prestressing.

503.03.05 Prestressing. All prestressing steel shall be tensioned by means of hydraulic jacks. Each jack shall be equipped with either a pressure gage or a load cell for determining the jacking stress, at the option of the Contractor. The pressure gage, if used, shall have an accurate reading dial at least six (6) inches in diameter. Each jack and its gage shall be calibrated as a unit with the cylinder extension in the approximate position that it will be at final jacking force, and shall be accompanied by a certified calibration chart. The load cell, if used, shall be calibrated and shall be provided with an indicator by means of which the prestressing force in the tendon may be determined. The range of the load cell shall be such that the lower ten (10) percent of the manufacturer's rated capacity will not be used in determining the jacking stress.

The tensioning of prestressing steel in any post-tensioned member and the cutting or releasing of prestressing steel in any pretensioned member shall not be performed until

tests on concrete cylinders made of the same concrete and cured under conditions identical to the member has attained the minimum compressive strength value specified for detensioning or stressing of the steel.

When ordered by the Engineer, prestressing steel tendons in pretensioned members, if tensioned individually, shall be checked by the Contractor for loss of prestress not more than three (3) hours prior to placing concrete for the members. The method and equipment for checking the loss of prestress shall be subject to approval by the Engineer. All tendons which show a loss of prestress in excess of three (3) percent shall be retensioned to the original computed jacking stress.

When prestressing steel in pretensioned members is tensioned at a temperature appreciably lower than the estimated temperature of the concrete and the prestressing steel at the time of initial set of the concrete, the calculated elongation of the prestressing steel shall be increased to compensate for the loss in stress, but in no case shall the jacking stress exceed seventy-five (75) percent of the specified minimum ultimate tensile strength of the prestressing steel.

Subject to prior approval by the Engineer, a portion of the total prestressing force may be applied to a member when the strength of the concrete in the member is less than the value shown on the plans and the member may then be moved. Approval by the Engineer of such partial prestressing and moving shall in no way relieve the Contractor of full responsibility for successfully constructing the members.

The cutting and releasing of prestressing steel in pretensioned members shall be performed in such an order that lateral eccentricity of prestress will be a minimum. The prestressing steel shall be cut off flush with the end of the member and the exposed ends of the prestressing steel shall be heavily coated with roofing asphalt or coal tar enamel.

Post-tensioning will not be permitted until it is demonstrated to the satisfaction of the Engineer that the prestressing steel is free and unbonded in the enclosure.

The tensioning process as applied to post-tensioned

members shall be so conducted that tension being applied and the elongation of the prestressing steel may be measured at all times. A record shall be kept of gage pressures and elongations at all times and shall be submitted to the Engineer for approval.

Prestressing steel in post-tensioned members shall be tensioned by simultaneous jacking at each end of the assembly, except as provided in the following:

(a) Jacking from one end of the assembly will be permitted on simple span members under sixty-five (65) feet in length, provided the calculations show that the maximum temporary tensile stress at the center of the span will not be more than seventy (70) percent of the specified minimum ultimate tensile strength of the prestressing steel.

(b) For simple span members sixty-five (65) feet and over in length, jacking from one end will be permitted, provided the calculations and also field tests demonstrate that the maximum temporary tensile stress at the center of the span will not be more than seventy (70) percent of the specified minimum ultimate tensile strength of the prestressing steel.

Unless otherwise permitted by the Engineer, half of the prestressing steel in each member shall be stressed from one end of the span and the other half from the opposite end.

Determination of the jacking stresses shall be supported by calculations, or by calculations and field tests when so specified, prepared by the Contractor. The Contractor shall submit his calculations to the Engineer for approval, and prior to making field tests shall submit details of his proposed gages and load devices for determining the jacking load at each end of the test prestressing unit to the Engineer for approval. Unless otherwise permitted by the Engineer, a load cell shall be used at the end opposite the jacking end. Measurement of elongation and stress shall agree within three (3) percent. The stress at the center will be calculated from the average of the end test loads. Jacking stresses within two (2) percent of the calculated required jacking stresses will be considered satisfactory.

The following friction coefficients shall be used in calculating friction losses. K represents the wobble of the ducts, and U represents the curvature in draped cables:

Type of Steel	Type of Duct	K	U
Bright metal wire or strand	Bright metal	0.002	0.30
	Galvanized	0.0015	0.25
Bright metal bars	Bright metal	0.0003	0.20
	Galvanized	0.0002	0.15

The maximum temporary tensile stress (jacking stress) in prestressing steel shall not exceed seventy-five (75) percent of the specified minimum ultimate tensile strength of the prestressing steel. The prestressing steel shall be anchored at stresses (initial stress) that will result in the ultimate retention of working forces of not less than those shown on the plans, but in no case shall the initial stress exceed seventy (70) percent of the specified minimum ultimate tensile strength of the prestressing steel.

The loss in stress in post-tensioned prestressing steel due to creep and shrinkage of concrete, creep of steel, and sequence of stressing, shall be assumed to be twenty-five thousand (25,000) pounds per square inch.

The loss in stress in pretensioned prestressing steel due to creep and shrinkage of concrete, creep of steel, and elastic compression of concrete shall be assumed to be thirty-five thousand (35,000) pounds per square inch.

Longitudinal prestressing steel in pretensioned members shall not be cut or released until tests on concrete cylinders indicate that the concrete in the member has attained a compressive strength of not less than the value shown on the plans or the following values, whichever is the greater.

Diameter of Strand	Compressive Strength
3/8"	3,500 psi
7/16"	4,000 psi
1/2"	4,000 psi

The working force in the prestressing steel shall be not less than the value shown on the plans. Unless otherwise specified or shown on the plans, the average working stress in the prestressing steel shall not exceed sixty (60) percent of the specified minimum ultimate tensile strength of the prestressing steel.

Working force and working stress will be considered as the force and stress remaining in the prestressing steel after all losses, including creep and shrinkage of concrete, elastic compression of concrete, creep of steel, losses in post-tensioned prestressing steel due to sequence of stressing, friction and take up of anchorages, and all other losses peculiar to the method or system of prestressing have taken place or have been provided for.

503.03.06 Curing. Curing shall conform to the applicable provisions of subsection 501.03.09, "Curing" and in addition the following steam curing requirements shall apply.

Any steam curing operation which deviates from the procedure listed below, shall be subject to the approval of the Engineer.

Steam curing shall be done under a suitable enclosure to contain the live steam in order to minimize moisture and heat losses. The initial application of the steam shall be from two (2) to four (4) hours after the final placement of concrete to allow the initial set of the concrete to take place. If retarders are used, the waiting period before application of the steam shall be from four (4) to six (6) hours. The steam shall be at one hundred (100) percent relative humidity to prevent loss of moisture and to provide excess moisture for proper hydration of the cement. Application of the steam shall not be directly on the concrete. During application of the steam the ambient air temperature shall increase at a rate not to exceed forty (40) degrees Fahrenheit per hour until a maximum temperature of from one hundred forty (140) degrees to one hundred sixty (160) degrees Fahrenheit is reached. The maximum temperature shall be held until the concrete has reached the desired strength. In discontinuing the steam, the ambient air temperature shall decrease at a rate not to exceed forty (40) degrees Fahrenheit per hour until a temperature has been reached about twenty (20) degrees Fahrenheit above the temperature of the air to which the concrete will be exposed. The concrete shall not be exposed to temperatures below freezing for six (6) days after casting.

503.03.07 Shipping. For prefabricated tendons, the Contractor shall give the Engineer at least ten (10) days notice before commencing the installation of end fittings or the heading of wires. The Engineer will inspect end fitting installations and wire headings while such fabrication is in progress at the plant and will arrange for the required testing of the material to be shipped to the site.

No prefabricated tendon shall be shipped to the site without first having been released by the Engineer, and each tendon shall be tagged before shipment for identification purposes at the site. All unidentified tendons received at the site will be rejected.

The release of any material by the Engineer shall not preclude subsequent rejection if the material is damaged in transit or later damaged or found to be defective.

503.03.08 Handling. Extreme care shall be exercised in handling, storing, moving, and erecting precast prestressed concrete members to avoid twisting, racking, or other distortion that would result in cracking or damage to the members. Precast prestressed members shall be handled, transported, and erected in an upright position, and the joints of support and directions of the reactions with respect to the member shall be approximately the same during transportation and storage as when the member is in its final position.

METHOD OF MEASUREMENT

503.04.01 Measurement. Measurement will be made per each of the various sizes and types for furnishing and erecting precast prestressed concrete members complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

503.05.01 Payment. The accepted quantities of precast prestressed concrete members measured as provided in subsection 503.04.01, "Measurement," will be paid for

at the contract unit prices bid for furnishing and erecting precast prestressed concrete members.

Payment therefor will be full compensation for all labor and for furnishing all items involved in the finished members.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) Precast Concrete Members	Each

SECTION 504

LIGHTWEIGHT CONCRETE FOR STRUCTURES

DESCRIPTION

504.01.01 General. This work shall consist of furnishing and placing lightweight Portland cement concrete in bridges, culverts, and other types of concrete structures. The construction of conventionally reinforced lightweight concrete structures shall conform to the requirements of Sections 501, "Portland Cement Concrete" and 502, "Concrete Structures."

MATERIALS

504.02.01 General. The materials used shall be those prescribed for the several items which constitute the finished work and shall conform to the requirements for such materials in the following sections:

Portland Cement Concrete	Section 501
Concrete Structures	Section 502
Aggregate for Portland Cement Products	Section 705

Lightweight concrete shall be composed of an intimate mixture of Portland cement, water and lightweight aggregates, with or without natural sand of normal specific gravity, and an air entraining admixture proportioned and mixed as hereinafter provided.

504.02.02 Admixtures. Admixtures shall conform to the applicable requirements of subsection 501.02.03, "Admixtures."

504.02.03 Concrete Making Properties. Lightweight concrete shall be subject to the following requirements and test methods:

Test	Test Designation	Requirements
Making Test Specimens (laboratory)	Nev. T455	------
Making Test Specimens (field)	Nev. T428	------
Compressive Strength	Nev. T475	Table I*
Unit Weight and Cement Factor (wet)	Nev. T435	Informational
Test for Popouts	Nev. T462	No surface popouts
Freezing and Thawing	Nev. T465	------
Air Content	Nev. T431	Table I
Slump	Nev. T438	Table I
Air Dried Weight	Nev. T458	Table I
Coring Concrete	ASTM C42	Informational†

*A test shall be defined as the average of the breaking strength of three cylinders at twenty-eight (28) days. Cylinders will be required for each fifty (50) cubic yards, or portion thereof, placed each day. On small structures such as manholes, inlets, culverts, wingwalls, etc., the Engineer may vary the number for small placements to cylinders for each twenty-five (25) cubic yards placed over a several day period. Other cylinders may be broken for informational purposes at various intervals when deemed advisable by the Engineer.

†When compressive strength tests as determined by Test Method No. Nev. T475 show compressive strengths less than the minimum required in Table I and liquidated damages are assessed in accordance with subsection 504.04.01, "Method of Measurement," then the Contractor may, at his option, core the concrete in question according to ASTM C42 and break three drilled specimens therefrom. The test specimens will be taken at a location approved by the Engineer and in his presence. The average compressive strength of the three drilled specimens shall be used as the test result. The test shall be performed by a certified testing laboratory approved by the Department. Test Method ASTM C42 shall be accomplished as soon after the twenty-eight (28) day compressive strengths tests as possible and in no case shall they be recognized as valid when more than twenty-eight (28) calendar days have elapsed from the time the Contractor has been notified in writing by the Engineer. The average of the compressive strengths of the drilled specimens as determined by Test Method ASTM C42 shall be the referee in determining liquidated damages. Compressive strength test results shall be correlated to the twenty-eight (28) day compressive strength requirement by Chart No. 2. Costs of performing the coring and related tests shall be borne by the Contractor.

CONSTRUCTION

504.03.01 General. Mixing water, storage of cement, measurement of materials, weighing and measuring equipment, condition of equipment, mixing conditions, and mixing equipment shall conform to the requirements of Sections 501, "Portland Cement Concrete" and 502, "Concrete Structures."

The Contractor shall notify the Engineer not less than thirty-two (32) calendar days in advance of use of the proposed sources of materials and shall make arrangements for the Engineer to obtain samples as required for testing purposes. Samples will not exceed five hundred (500) pounds for each separate grading. The Contractor shall furnish a written statement giving the cement factor in

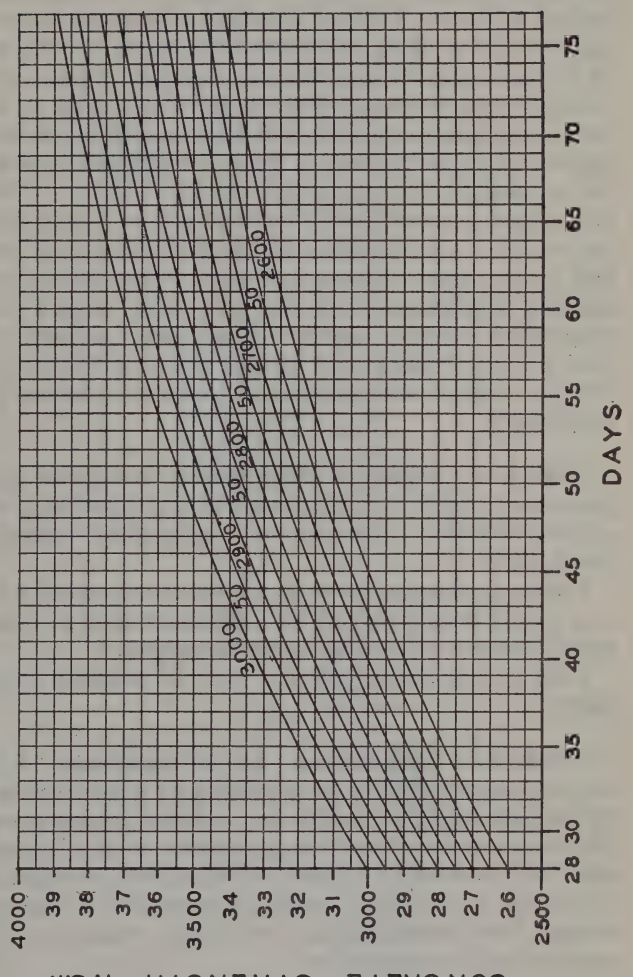


CHART NO. 2
CONCRETE STRENGTH P.S.I.
4000
3500
3000
2500
39
38
37
36
34
33
32
31
29
28
27
26
28 30 35 40 45 50 55 60 65 70 75
DAYS
3000 50
2900 50
2800 50
2700 50
2600 50

sacks per cubic yard, the proportions of cement and each size of aggregate in a saturated surface dry condition, the slump, and the percentage of air in the concrete proposed for use in the work. If the Contractor proposes to use an admixture other than an air-entraining agent, he shall state its complete brand name and the quantity proposed to be used per sack of cement. The Engineer, after making such tests as he deems advisable, will either accept the proposed materials and proportions or suggest modifications needed for acceptance. After acceptance by the Engineer of batch proportions and materials, they shall not be altered during the course of the work except as found necessary to maintain yield, cement factor, and unit weight within specification requirements. In no case shall revised batch proportions result in concrete that contains an amount of total water per cubic yard greater than one hundred five (105) percent of that contained in concrete of the accepted proportions.

504.03.02 Storage of Aggregates. Storage of aggregates shall conform to the pertinent requirements of subsection 501.03.03, "Storage of Aggregates," except as noted below.

Lightweight aggregate shall be stockpiled on the job or at a central batching plant for a minimum time of twenty-four (24) hours prior to its use in the project.

Fine and coarse aggregates shall be stockpiled separately.

504.03.03 Classification and Proportions. Lightweight concrete shall be proportioned by weight, using the lightweight aggregates under test, such that one or more of the compressive strength requirements in the following table will be satisfied without exceeding the corresponding maximum unit weight values. Intermediate values for strength and corresponding unit weight values, may be established by interpolation.

At the option of the Contractor, natural fine aggregate may be substituted for fine, lightweight aggregate provided such substitution does not result in producing concrete having a weight in excess of maximum.

TABLE I

Class	Sacks Cement Per Cu. Yd., Min. – Max.	Min. Comp. Str. (28 day) PSI	Slump Range, Inches	Air-Dried Weight, Max. Lb. Cu. Ft.	Entrained Air Range (%)	Unit Weight Variation*	Max. Water, Gal. Per Sack Cement†
LA	6.0–7.0	3,000	1–4	110	0	± 3 lbs.	6
LAA	6.0–7.0	3,000	1–4	110	3–5	± 3 lbs.	5

*Batches of lightweight concrete placed in the work shall not vary more than ± 3 pounds per cubic foot in unit weight from the design mix. The cement factor of any individual batch placed in the work shall not be more than 0.15 sack per cubic yard less, nor more than 0.25 sack per cubic yard greater than the designated factor (sacks of cement per cubic yard). Aggregates shall be batched and reported to the Resident Engineer by weight but the weights used may be varied as necessary to comply with the above tolerances in cement factor and unit weight.

†Based on aggregate in a saturated surface dry condition.

504.03.04 Mixing. Lightweight aggregates in combination with natural sand, if used, shall be of such character that workable concrete of the properties specified herein will be obtained. Should premoistening be required, it shall be done uniformly at least twenty-four (24) hours in advance of batching.

The batch shall be so charged that three-fourths of the total mixing water and admixtures be introduced in the mixer in advance of the aggregates. The aggregates shall then be introduced and mixed for a minimum of forty-five (45) seconds. The amount of absorption by the aggregate will be the determining factor in mixing time. The cement and final water shall be added and mixing completed. The total mixing time for stationary mixers shall not be less than three (3) minutes. Minimum mixing for concrete mixed in trucks shall be one hundred (100) revolutions of the drum.

The drum on truck mixers shall be operated at high speed while charging it with aggregate. Cement shall be introduced into the mixing drum while it is rotating at slow speed. Immediately prior to discharge of the concrete, the drum shall be rotated at high speed for at least sixty (60) seconds.

METHOD OF MEASUREMENT

504.04.01 Measurement. The quantity of lightweight concrete to be measured for payment will be the number of cubic yards complete and in place. The estimated quantity shown on the plans, plus or minus quantities covered by change order, will be the quantity used for payment. The Engineer or the Contractor may, however, request a final measurement. The Contractor's request for final measurement shall be in writing. Final measurement will be made according to the dimensions shown on the plans plus or minus approved changes and quantities derived therefrom will be the quantities used for payment. Each class of lightweight concrete will be considered separately. Only those quantities complete and in place will be measured for payment.

It is agreed by the parties to the contract that (a) in case Portland cement concrete of Class LA or LAA does

not conform to the twenty-eight (28) day compressive strength requirements of Table I of Section 504, damage will be sustained by the Department, and (b) it is extremely difficult to ascertain the actual damage which the Department will sustain; therefor, it is agreed that the Department will deduct from the Contractor as liquidated damages, money due or to become due the Contractor from the Department, a percentage of the contract unit bid price as set forth in the following schedule:

28-Day Compressive Strength—PSI	Liquidated Damage—Per Unit Bid Price (percent)
3,000	0
2,999–2,950	2
2,949–2,900	6
2,899–2,850	12
2,849–2,800	21
2,799–2,750	33
2,749–2,700	47
2,699–2,650	64
2,649–2,600	82
2,599 or less	100

Concrete shown by test to have less than two thousand six hundred (2,600) psi compressive strength shall be removed and replaced, or at the option of the Engineer, may be left in place without payment.

No measurement or other allowance will be made for work, material for forms, falsework, cofferdams, pumping, bracing, etc.

The quantity of concrete involved in fillets, scorings, and chamfers two (2) square inches or less in cross sectional area shall be neglected. No deduction shall be made for the volume of concrete displaced by reinforcing steel, expansion joint material, drainage and weep holes, pipes, conduits, and ducts embedded in concrete. Deduction shall be made for the volume of timber piles, concrete piles, and cast-in-place piles embedded in the concrete.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

504.05.01 Payment. The accepted quantity of concrete measured as provided in subsection 504.04.01,

"Measurement," will be paid for at the contract unit price bid per cubic yard for the class of lightweight concrete specified. Reinforcing steel will be paid for as provided in Section 505, "Reinforcing Steel." All metal parts, fabrics, pads, joint filler, drains, and any other materials not specifically mentioned for payment herein, will be considered subsidiary to the other pay items of the work and no further compensation will be allowed therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Class (....) Lightweight Concrete	Cubic Yard

SECTION 505

REINFORCING STEEL

DESCRIPTION

505.01.01 General. This work shall consist of furnishing and placing reinforcing steel and mesh reinforcing in accordance with these specifications and in conformity with the plans.

MATERIALS

505.02.01 General. Materials shall conform to the requirements specified in the following subsections:

Fabricated Steel Bar or Rod Mats Reinforcement	Subsection 713.03.02
Bar Steel Reinforcement	Subsection 713.03.01
Welded Steel Wire Fabric Reinforcement	Subsection 713.03.03

505.02.02 Samples. One extra bar of each diameter shall be furnished per contract for each one hundred (100) tons or fraction thereof. This bar shall be from the longest bar of each size so that it, or a portion of it, can be used to replace any bar of that diameter which is selected to be used as a field sample. The field sample must be of sufficient length to provide for two (2)–two (2) foot samples of each diameter. The extra bars shall be indicated on the fabricator's details.

CONSTRUCTION

505.03.01 Bending Diagrams. Before placing reinforcing steel, two copies of a list of all reinforcing steel shall be furnished to the Engineer at the site for his use in administering the contract. Furnishing such lists to the Engineer shall not be construed to mean that the lists will be reviewed for accuracy. The Contractor shall be wholly and completely responsible for the accuracy of the lists and for furnishing and placing all bar reinforcing steel in accordance with the details shown on the plans and as specified.

505.03.02 Protection of Materials. Reinforcing steel shall be protected at all times from damage. When placed in the work, the reinforcing steel shall be free from dirt, detrimental scale, paint, oil, or other foreign substance. However, when steel has on its surface loose mill scale or dust which is easily removable, it may be cleaned by a satisfactory method, if approved by the Engineer.

505.03.03 Bending. Bent bar reinforcement shall be cold bent to the shape shown on the plans; and, unless otherwise provided on the plans or by authorization, bends shall be made in accordance with the ACI Manual of Standard Practice.

505.03.04 Placing and Fastening. All bar reinforcement shall be accurately placed in the positions shown on the plans and firmly held during the placing and setting of concrete. Bars shall be tied at all intersections except where spacing is less than one (1) foot in each direction, when alternate intersections shall be tied.

Distances from the vertical and horizontal forms shall be maintained by means of stays, ties, hangers, or other approved supports. Metal chairs which are in contact with the exterior surface of the concrete shall be galvanized. Layers of bars shall be separated by metal chairs. The use of pebbles, pieces of broken stone or brick, metal pipe, and wooden blocks will not be permitted. Reinforcement in any member shall be placed, and then inspected and approved by the Engineer, before the placing of concrete begins. Concrete placed in violation of this provision may be rejected and its removal required.

If mesh reinforcement is shipped in rolls, it shall be straightened into flat sheets before being placed.

505.03.05 Splicing. All reinforcement bars shall be furnished in the full lengths indicated on the plans. Splicing of bars, except where shown on the plans, will not be permitted without the written approval of the Engineer. Splices shall be staggered as far as possible. Unless otherwise shown on the plans, bars near the top of beams and

girders having more than twelve (12) inches of concrete under the bars shall be lapped thirty-five (35) diameters and all other bars shall be lapped twenty (20) diameters to make the splice. In lapped splices, the bars shall be placed in contact and wired together. Welding of reinforcing steel shall be done only if detailed on the plans or authorized by the Engineer in writing. Welding shall conform to the specifications for Welded Highway and Railway Bridges of the American Welding Society.

Sheets of mesh reinforcement shall overlap each other sufficiently to maintain a uniform strength and shall be securely fastened at the ends and edges. The edge lap shall not be less than one (1) mesh in width.

505.03.06 Substitutions. Substitution of different size bars will be permitted only with specific authorization by the Engineer. The bars substituted shall have an area equivalent to the design area or larger.

METHOD OF MEASUREMENT

505.04.01 Measurement. The calculated quantity shown on the plans, plus or minus quantities covered by approved changes, will be the quantity used for payment. The Engineer or the Contractor may request final measurement if a possible error is suspected in the quantities shown on the plans. The Contractor's request for final measurement shall be in writing. Final measurement will be made according to the dimensions shown on the plans plus or minus approved changes and quantities derived therefrom will be the quantity used for payment. The quantity of reinforcing steel measured for payment will be the number of pounds complete and in place.

The calculated weights of the plain and deformed bars shall be based on the following table:

Size No.	Nominal Diameter in Inches	Weight Per Foot in Pounds
2	0.250	0.167
3	0.375	0.376
4	0.500	0.668
5	0.625	1.043
6	0.750	1.502
7	0.875	2.044
8	1.000	2.670
9	1.128	3.400
10	1.270	4.303
11	1.410	5.313
14	1.692	7.650
18	2.256	13.600

The quantity of mesh reinforcement to be measured for payment will be the number of square yards complete and in place measured along the plane of placement. No allowance will be made for laps.

All measurements will be made in accordance with subsection 10961, "Measurement of Quantities."

BASIS OF PAYMENT

505.05.01 Payment. The accepted quantity of reinforcing steel measured as provided in subsection 505.04.01, "Measurement," will be paid for at the contract unit price bid per pound.

The accepted quantity of mesh reinforcement measured as provided in subsection 505.04.01, "Measurement," will be paid for at the contract unit price bid per square yard.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Reinforcing Steel	Pound
Mesh Reinforcing	Square Yard

SECTION 506

STEEL STRUCTURES

DESCRIPTION

506.01.01 General. This item shall consist of furnishing, fabricating, casting, machining, or otherwise preparing, transporting, erecting, and painting any or all structural steel, rivet and eye bar steel, steel forgings, castings, and any other metal of the type, shape, dimensions, and quality, required by these specifications or as shown on the plans.

MATERIALS

506.02.01 General. Materials shall meet the pertinent requirements of the following sections:

Structural and Eyebar Steel	Section 710
Aluminum for Bridge Rail	Section 711
Miscellaneous Metals	Section 712
Paint	Section 714
Galvanizing	Section 715

Turned bolts shall meet the material specifications set forth for Structural Rivet Steel. Anchor bolts, nuts and washers shall be of structural steel, galvanized in accordance with ASTM Designation A153. Bolts for fastening tubes to the rail posts sockets shall be stainless steel.

CONSTRUCTION

506.03.01 Shop Drawings. Shop drawings shall consist of shop detail erection and other working plans showing dimensions, sizes of material, details, and other information necessary for the complete fabrication and erection of the metal work. The drawings shall be prepared on sheets twenty-two (22) inches wide by thirty-six (36) inches. The original drawings may be made either on paper or on cloth, but the details must be drawn so that the prints will be clear and legible.

Unless otherwise requested, the Contractor shall submit to the Engineer, for approval, two (2) sets of checked drawings. The Engineer reserves the right to refuse prints

of shop drawings which are not clear and legible. Upon approval the Contractor shall furnish the Engineer with the number of sets of shop drawings requested and the original tracings or Van Dyke negatives thereof. All shop plans shall be submitted for approval at least fifteen (15) days before fabrication is started and no material shall be fabricated until the plans have been finally approved by the Engineer. The shop drawings as approved by the Engineer shall become a part of the contract; provided, however, that any substitution of sections contemplated by the shop drawings different from sections shown on the plans shall be made only when approved by the Engineer and in such case, additional costs resulting from such substitution shall be borne by the Contractor.

After approval there shall be no deviation from the shop drawings or changes made thereon without the prior approval of the Engineer.

Approval of shop drawings shall be understood to be an acceptance of the character and sufficiency of the details and not a check of any dimensions. Checking shop drawings is intended as a means of facilitating the work and avoiding errors so far as possible, but it is expressly understood that it will not relieve the Contractor from the responsibility in regard to errors or omissions on said shop drawings.

The contract price shall include the cost of furnishing all shop drawings and the Contractor will be allowed no extra compensation for such drawings.

506.03.02 Notice of Beginning Work. The Contractor shall give the Engineer ample notice of the beginning of work at the mill or in the shop so that inspection may be provided. "Mill" means any rolling mill or foundry where material for the work is to be manufactured. No material shall be manufactured or work done in the shop before the Engineer has authorized the fabrication. Any purchase of material prior to fabrication authorization shall be at the Contractor's risk.

506.03.03 Inspection and Testing. The Contractor shall furnish test specimens as required free of charge.

The Contractor will require the fabricator of structural carbon steel or structural alloy steel to furnish the Engineer with two (2) certified copies of mill inspection and test reports showing both physical and chemical tests of each heat from which material is to be used.

All structural steel and miscellaneous metals described in subsection 506.02.01, "General," shall be subject to shop inspection by the Engineer at his option.

The Contractor shall furnish facilities for the inspection of material or workmanship in the shop and the inspector shall be allowed free access to the necessary parts of the work.

The inspector shall have the authority to reject any material or workmanship which does not meet the requirements of the specifications.

The acceptance of any material or finished members by the inspector shall not be a bar to their subsequent rejection if found defective.

Inspection at the shop is intended as a means of facilitating the work and avoiding errors so far as possible but it is expressly understood that it will not relieve the Contractor from responsibility in regard to imperfect material or workmanship or the necessity for replacing the same.

The Contractor shall furnish the Engineer with three (3) copies of mill orders and shipping statements, the weights of the individual members shall be shown on the statements.

Shop inspection of rail pipe and tubes will in most cases be waived and the Contractor permitted to ship subject to inspection at the project site. The field inspection will cover the general appearance, size, thickness, etc., of the pipe and tubing. Conformance of chemical and mechanical properties to requirements of the specifications will also be considered before the material is approved. Shop inspection of rail posts will be made on the first few rail posts castings furnished for each project in order to establish a satisfactory class of finish and workmanship. When shop inspection is waived on a portion of the handrail posts for a project, a careful inspection will be made in the field to determine the acceptability of these posts on the basis of

the finish and workmanship as compared to that of the other posts previously inspected and approved.

Fabrication of aluminum alloy material shall, in general, conform to or be equivalent to fabrication methods and practices recommended in the handbooks of the major producers of aluminum materials and specifically the following requirements:

(a) Material shall be sawed, routed or milled.

(b) Flame cutting is not permissible.

(c) Tubing may be heated to a temperature not exceeding four hundred (400) degrees Fahrenheit for a period not exceeding fifteen (15) minutes to facilitate bending.

(d) Holes in pipe and tubing shall be drilled. Holes in castings shall be cored and reamed, or drilled from the solid. Seats for pipe shall be finished smooth.

The fabrication and handling of aluminum materials in the shop and field shall be performed in a manner to prevent scoring or marring of the surfaces. An objectionable appearance resulting from such scoring or marring shall be cause for rejection of the material. Sleeves and rails shall be fabricated in lengths indicated on the plans.

The finishing of rail posts shall be performed after fabrication is completed. All fins, pipes, and other casting irregularities and all drilling, reaming, and other fabrication marks shall be removed.

506.03.04 Storage. Structural material either plain or fabricated shall be stored at the bridge shop above the ground upon platforms, skids, or other supports. It shall be kept free from dirt, grease, and other foreign matter and shall be protected as far as practicable from corrosion.

506.03.05 Straightening. Rolled material, before being laid off or worked, must be straight. If straightening is necessary it shall be done by methods that will not injure the metal. Sharp kinks and bends will be cause for rejection of the material.

506.03.06 Rivet Holes. Rivet holes in carbon steel which is more than three-fourths (¾) inch in thickness

shall be subpunched and reamed, subdrilled and reamed, or drilled full size from the solid. Unless otherwise specified, all rivet holes in such material which is three-fourths (¾) inch or less in thickness may be punched full size except where such holes match holes in thicker adjacent material. In such cases the holes in the thinner material shall be subpunched (or subdrilled) and reamed while the parts are assembled or drilled full size from the solid while the parts are assembled.

Rivet holes in material of alloy steels which is more than five-eighths (⅝) inch in thickness shall be subpunched and reamed, subdrilled and reamed or drilled full size from the solid. Unless otherwise specified, all rivet holes in such material which is five-eighths (⅝) inch or less in thickness may be punched full size except where such holes match holes in thicker adjacent material. In such cases the holes in the thinner material shall be subpunched (or subdrilled) and reamed while the parts are assembled or drilled full size from the solid while the parts are assembled.

Where there are five or more thicknesses of metal, all holes regardless of the thicknesses of the separate pieces shall be subpunched (or subdrilled) and reamed while the parts are assembled or drilled full size from the solid while the parts are assembled.

Full sized punched holes shall be one-sixteenth ($\frac{1}{16}$) inch larger than the nominal diameter of the rivet. The diameter of the die shall not exceed the diameter of the punch by more than one-sixteenth ($\frac{1}{16}$) inch. If any holes must be enlarged to admit the rivets, they shall be reamed. Holes must be clean cut, without torn or ragged edges. Poor matching or mispunched holes will be cause for rejection.

Subpunched (or subdrilled) and reamed holes shall be punched or drilled not less than three-sixteenths ($\frac{3}{16}$) inch smaller than the nominal diameter of the rivet. After punching or drilling, the holes shall be reamed to a diameter of one-sixteenth ($\frac{1}{16}$) inch larger than the nominal diameter of the rivet. The punch and die shall have the same relative sizes as specified for full sized punched holes. Reamed holes shall be cylindrical and perpendicular to the member. Where practicable, reamers shall be directed by

mechanical means. Burrs on the outside surfaces shall be removed. Poor matching of holes will be cause for rejection. Reaming of rivet holes shall be done with twist drills or with short taper reamers.

Full size drill holes shall be one-sixteenth ($1/16$) inch larger than the nominal diameter of the rivet. Burrs on the outside surfaces shall be removed.

All holes punched full size, subpunched or subdrilled shall be so accurately punched after assembly (before any reaming is done) a cylindrical pin one-eighth ($1/8$) inch smaller in diameter than the nominal size in the punched hole may be entered perpendicular to the face of the member, without drifting, in at least seventy-five (75) percent of the contiguous holes in the same plane. If the requirement is not fulfilled, the badly punched pieces shall be rejected.

When holes are reamed or drilled eighty-five (85) percent of the holes in any contiguous group shall, after reaming or drilling, show no offset greater than one thirty-second ($1/32$) inch between adjacent thicknesses of metal.

506.03.07 Rivets. Size of rivets called for on the plans shall be the size before heating.

Rivet heads shall be of standard shape unless otherwise specified, and of uniform size for the diameter of rivet. They shall be full, neatly made, concentric with rivet holes, and in full contact with the surface of the member.

506.03.08 Shop Riveting. Rivets shall be heated uniformly to a "light cherry red color" and shall be driven while hot. Any rivet whose point is heated more than the remainder shall not be driven. When a rivet is ready for driving, it shall be free from slag, scale, or other adhering matter. Any rivet which, in the opinion of the Engineer, is scaled excessively, shall be rejected.

All rivets that are loose, burned, badly formed, or otherwise defective shall be removed and replaced with satisfactory rivets. Any rivet whose head is deficient in size or whose head is driven off center will be considered defective and shall be removed. Stitch rivets that are loosened by the driving of adjacent rivets shall be removed and replaced

with satisfactory rivets. Caulking or recupping of rivet heads will not be permitted.

Shop rivets shall be driven by direct-acting rivet machines where practicable. Approved beveled rivet sets shall be used for forming rivet heads on sloping surfaces. When the use of a direct-acting rivet machine is not practicable, pneumatic hammers of approved size shall be used. Pneumatic bucking tools will be required, when in the opinion of the Engineer, the size and length of the rivets warrant their use.

Rivets may be driven cold provided their diameter is not over three-eighths (⅜) inch.

506.03.09 Subpunching, Drilling, and Reaming. Unless otherwise specified, rivet holes and connections and splices (shop and field) of main truss or arch members, continuous beams, plate girders and rigid frames and rivet holes in plate girder flanges, and stiffeners, intermediate stiffeners intended as supports for concentrated loads, and web splices shall either be subpunched (or subdrilled) and reamed while shop assembled or drilled to full size from the solid while assembled at the shop. The assembly, including camber, alignment, accuracy of holes and mill joints, shall be approved by the Engineer before reaming is commenced.

Unless otherwise specified, each individual (full length) truss, arch, continuous beam, or girder shall be assembled at the shop before reaming or drilling is commenced. During shop assembly all members shall be supported at such intervals and in such manner as is necessary to avoid undesirable deflections.

All holes for floor beams and stringer field end connections shall be subpunched and reamed to a steel template.

506.03.10 Bolts and Bolted Connections. (a) General. Bolted connections shall not be used unless called for in the contract documents. Where bolted connections are permitted, the bolts furnished shall be unfinished bolts, high-tensile bolts, or ribbed bolts as specified. Ribbed high-tensile bolts or high-tensile strength bolts may be substituted for field rivets in locations where, in the opinion of

the Engineer, it is impractical to drive rivets. Bolts shall be of such length that they will extend entirely through the nut, but not more than three-eighths (⅜) inch beyond. The Contractor shall furnish sufficient bolts of each type for each size and length to bolt such connections as called for with an ample surplus to replace those lost or rejected.

The holes shall be truly cylindrical. Holes shall be at right angles to the surface of the metal so that both head and nut will bear squarely against the metal. Bolts shall be driven accurately into the holes without damaging the thread. A snap shall be used to prevent damaging the heads.

(b) Unfinished Bolts. Unfinished bolts shall be standard bolts with hexagonal heads and nuts. The diameter of the bolt holes will be one-sixteenth ($\frac{1}{16}$) inch greater than the diameter of the bolt. Threads on unfinished bolts shall be outside the grip and lock washers placed under the nuts of such bolts.

(c) High-Tensile-Strength Bolts. The assembly of structural connections using high-tensile-strength bolts and nuts with hardened washers where the initial tension in the bolt produces friction on the contact surfaces of the connected pieces sufficient in magnitude to resist shear shall conform to the following:

High-tensile-strength bolts may be substituted for rivets as indicated by the plans or special provisions.

Except as otherwise provided in this subsection, construction shall conform to applicable specifications for riveted structures. Bolt lengths shall be determined by adding the values given in Table 1 to the total thickness of connected material. The values in Table 1 compensate for thickness of nut, one flat washer and bolt point. The total length shall be adjusted to the next one-fourth (¼) inch increment to five (5) inch length and to the next longer one-half (½) inch increment for lengths over five (5) inches.

If other than the standard thickness of circular washer as given in Table 2 is used, the necessary bolt length shall be adjusted accordingly. Where beveled washers of the dimensions given in Table 2 are used, an additional one-

eighth (⅛) inch shall be added for each such beveled washer.

Circular washers shall be flat and smooth and their dimensions shall not be less than would conform to the current requirements of the American Standards Association (ASA Designation: B 27.2) as given in Table 2. Where clearance is necessary, washers may be clipped on one side to a point not closer than seven-eighths (⅞) of the bolt diameter from the center of the washer. Where bearing faces of the bolted parts have a slope of more than 1:20 with respect to a plane normal to the bolt axis, smooth beveled washers shall be used to compensate for lack of parallelism.

Table 1—Bolt Lengths

Bolt Size (inches)	Add to Grip (inches)
½	⅞
⅝	1⅛
¾	1¼
⅞	1⅜
1	1½
1⅛	1¾
1¼	1⅞

Bolt dimensions shall conform to the current requirements for Regular Semi-Finished Hexagon Nuts of the American Standards Association (ASA Designation: B 18.2).

Nut dimensions shall conform to the current requirements for Heavy Semi-Finished Hexagon Nuts of the American Standards Association (ASA Designation: B 18.2).

Holes may be punched, subpunched and reamed, or drilled, as required by the applicable specifications for riveted construction and shall be of a diameter not more than one sixteenth ($\frac{1}{16}$) inch in excess of the nominal bolt diameter.

Bolted parts shall fit solidly together when assembled. Contact surfaces, including those adjacent to the washers, shall be descaled or carry the normal tight mill scale. Contact surfaces shall be free of dirt, oil, loose scale, burrs, pits, and other defects that would prevent solid seating of the parts.

Table 2—Washer Dimensions

Thickness Gage No.	Circular Washers		Bolt Size (inches)	Square Beveled Washers for American Standard Beams and Channels			
	Outside Diam. (inches)	Inside Diam. (inches)		Inside Diam. (inches)	Width (inches)	Mean Thickness	Slope
12	1⅜	9/16	½	9/16	1¾	5/16	1:6
10	1¾	11/16	⅝	11/16	1¾	5/16	1:6
9	2	13/16	¾	13/16	1¾	5/16	1:6
8	2¼	15/16	⅞	15/16	1¾	5/16	1:6
8	2½	1 1/16	1	1 1/16	1¾	5/16	1:6
8	2¾	1¼	1⅛	1¼	2¼	5/16	1:6
8	3	1⅜	1¼	1⅜	2¼	5/16	1:6

Contact surfaces of joints shall be free of paint or lacquer unless otherwise indicated by the plans or special provisions.

Connections shall be assembled with a hardened washer under the bolt head or nut, whichever is the element turned in tightening. The washer may be omitted under the head of heavy semi-finished hexagon bolts or under heavy semi-finished hexagon nuts, when these are not the elements turned. Surfaces of bolted parts in contact with the bolt head and nut shall be parallel, except flat washers may be used on surfaces having a slope not greater than 1:20 with respect to a plane normal to the bolt axis, provided the nut is torqued against a non-sloping surface. For slopes greater than 1:20 smooth beveled washers shall be used to produce parallelism.

All nuts shall be tightened to give at least the required minimum bolt tension values given in Table 3 upon completion of the joint. Tightening shall be done with properly calibrated wrenches or by the turn-of-nut method.

Table 3—Bolt Tension

Bolt Size (inches)	Required Minimum Bolt Tension (lbs.*)
½	12,050
⅝	19,200
¾	28,400
⅞	36,050
1	47,250
1⅛	56,450
1¼	71,700
1⅜	85,450
1½	104,000

*Equal to the proof load of bolt given in ASTM A325.

Calibrated Wrenches

When calibrated wrenches are used to provide the bolt tension specified in Table 3, their setting shall be such as to induce a bolt tension slightly in excess of this value. These wrenches shall be calibrated by tightening, in a device capable of indicating actual bolt tension, not less than three typical bolts from the lot to be installed. Power wrenches shall be adjusted to stall or cut-out at the selected tension. If manual torque wrenches are used, the torque

indication corresponding to the calibrating tension shall be noted and used in the installation of all bolts of the tested lot. Nuts shall be in tightening motion when torque is measured. When using calibrated wrenches to install several bolts in a single joint, the wrench shall be returned to "touch up" bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the prescribed amount.

Turn of Nut

When the turn-of-nut method is used to provide the bolt tension specified in Table 3, there shall first be enough bolts brought to a "snug tight" condition to insure that the parts of the joint are brought into full contact with each other. Snug tight is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified below with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

NUT ROTATION[ab] FROM SNUG TIGHT CONDITION

(Disposition of Outer Faces of Bolted Parts)

Both Faces Normal to Bolt Axis, or One Face Normal to Axis and Other		Both Faces Sloped[c] From Normal to Bolt Axis (bevel washers not used)
—Face Sloped[c] (bevel washer not used)—		
Bolt Length[d] Not Exceeding 8 Diameters or 8 Inches	Bolt Length[d] Exceeding 8 Diameters or 8 Inches	For all Lengths of Bolts
½ turn	⅔ turn	¾ turn

[a]For coarse thread heavy hexagon structural bolts of all sizes and lengths and heavy hexagon semi-finished nuts.

[b]Nut rotation is rotation relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation: ⅙ turn (60°) over and nothing under.

[c]Slope 1:20 maximum.

[d]Bolt length is measured from underside of head to extreme end of point.

506.03.11 Shop Assembly. Shop assembly of trusses, arches, continuous beams, continuous plate girders, plate

girders, and rigid frames shall be according to subsection 506.03.09, "Subpunching, Drilling, and Reaming." All members shall be match marked before being disassembled.

Complete shop assembly of an entire structure, including floor system, which may be necessary in the case of complicated design or of skewed or super-elevated structure shall be done only if required by the special provisions.

The several component parts of a built-up member shall be straight and close fitting.

Surfaces of metal in contact shall be cleaned before assembling. The parts of a member shall be assembled, well pinned, and firmly drawn together with bolts before drilling, reaming, or riveting is commenced. Assembled pieces shall be taken apart, if necessary, for the removal of burrs and shavings produced by the operations. The member shall be free from twists, bends, and other deformations.

End connections, angles, stiffener angles, and similar parts shall be carefully adjusted to correct positions and bolted, clamped, or otherwise firmly held in place until riveted.

The drifting done during assembling shall be only such as to bring the parts into position, and not sufficient to enlarge the holes or distort the metal. If any holes must be enlarged to admit the rivets, they shall be reamed.

Parts not completely riveted in the shop shall be secured by bolts insofar as practicable to prevent damage in shipment and handling.

Connecting parts assembled in the shop for the purpose of reaming holes in field connections shall be match marked, and a diagram showing such marks shall be furnished to the Engineer.

506.03.12 Edge Planing. Sheared edges of plates more than five-eighths (⅝) inch in thickness and carrying calculated stress shall be planed to a depth of one-fourth (¼) inch. Re-entrant cuts shall be filleted to a radius of three-fourths (¾) inch.

506.03.13 Facing of Bearing Surfaces. The surface finish of bearing and base plates and other bearing surfaces that are to come in contact with each other or with concrete shall meet the American Standards Association surface roughness requirements as defined in ASA B 46.1–55, Surface Roughness, Waviness and Lay, Part 1:

Steel slabs	ASA 2,000
Heavy plates in contact in shoes to be welded	ASA 1,000
Milled ends of compression members, stiffeners, and fillers	ASA 500
Bridge rollers and rockers	ASA 250
Pins and pin holes	ASA 125
Sliding bearings	ASA 125

Surfaces of bronze bearing plates intended for sliding contact shall be planed parallel to the movement of the spans and polished.

506.03.14 Abutting Joints. Abutting joints in compression members of trusses and in columns shall be milled.

Openings and abutting joints in tension members shall not exceed one-fourth (¼) inch.

Abutting joints of continuous I beam spans shall be square and tight fit.

Abutting joints in top and bottom flanges of plate girders shall be square and tight fit.

506.03.15 Flame Cutting. Steel or wrought iron may be flame cut, provided a smooth surface free from cracks and notches is secured, and provided that an accurate profile is secured by the use of a mechanical guide. Freehand flame cutting shall be done only where approved by the Engineer. The cutting flame shall be so adjusted and manipulated as to avoid cutting beyond (inside) the prescribed lines. Members with excessive cracking or cracks of depth exceeding three-sixteenths ($\frac{3}{16}$) inch will not be acceptable. Flame cut surfaces shall meet the American Standards Association surface roughness rating value of 1,000. Edges shall have their corners rounded to one-sixteenth ($\frac{1}{16}$) inch radius by grinding after flame cutting.

Re-entrant cuts shall be filleted to a radius of not less than three-fourths (¾) inch.

Occasional notches, cracks, and surface roughness, not more than three-sixteenths (3/16) inch deep on otherwise satisfactory cut surfaces, may be removed by planing or grinding. Defects of flame cut edges shall not be repaired by welding except with the express approval of the Engineer for occasional notches or gouges less than three-eighths (⅜) inch deep in a type of steel considered weldable in the Specifications for Welded Highway and Railway Bridges of the American Welding Society. Such weld repair shall be made by suitably preparing the defect, welding with low-hydrogen electrodes not exceeding five thirty-seconds (5/32) inch in diameter, observing the applicable requirements of the American Welding Society Specifications and grinding the completed weld smooth and flush with the adjacent surface to produce a workmanlike finish. Corrections of the defects must be faired with the surfaces of the cuts on a bevel of 1 to 6 or less.

506.03.16 End Connection Angles. Floorbeams, stringers, and girders having end connection angles shall be built to exact length shown on the plans measured between the heels of the connection angles, with a permissible tolerance of plus 0 inch to minus one-sixteenth (1/16) inch. Where continuity is to be required, end connections shall be faced. The thickness of the connection angles shall not be less than three-eighths (⅜) inch, nor less than that shown on the detail drawings.

506.03.17 Lacing Bars. The ends of lacing bars shall be neatly rounded unless another form is required.

506.03.18 Web Plates. In girders having no cover plates and not to be encased in concrete, the top edge of the web plate shall not extend above the backs of the flange angles and shall not be more than one-eighth (⅛) inch below at any point. Any portion of the plate projecting beyond the angles shall be chipped flush with the backs of the angles. Web plates or girders having

cover plates may be one-half (½) inch less in width than the distance back to back of flange angles.

Splices in webs of girders without cover plates shall be sealed on the top by welding.

At web splices, the clearance between the ends of the web plates shall not exceed three-eighths (⅜) inch. The clearance at the top and bottom ends of web splice plates shall not exceed one-fourth (¼) inch.

506.03.19 Stud Shear Connectors. (a) Stud shear connectors shall be of a design suitable for end welding and shall be end welded to steel beams, girders, or plates with automatically timed stud welding equipment. The type, size or diameter, and length of stud shall be as specified in the contract documents. (See Figure No. 1 for allowable tolerances or dimensions.) A maximum variation of one (1) inch from the location shown will be accepted provided the adjacent studs are not closer than two and one-half (2½) inches center to center. The clear distance between the edge of a girder flange and the edge of the shear connectors shall be not less than one (1) inch. Fillet welds varying in size from three-sixteenths (3/16) inch to five-sixteenths (5/16) inch are satisfactory provided the studs pass all other tests required. Adequate provision shall be made in the fabrication of structural members to compensate for loss of camber due to welding of the shear connectors.

(b) Studs shall not be painted or galvanized. The studs shall be free from rust, scale, rust pits, and oil at the time of welding and immediately before the concrete is placed. The beam surface to which the studs are welded shall be free from excessive mill scale, rust, dirt, paint, grease, or any other material which might impair the quality of the weld. When necessary to obtain satisfactory welds, the areas on the beam, girder, or plate to which the studs are to be welded shall be wire-brushed, peened, prick-punched, or ground free of scale or rust.

(c) Welding shall not be done when the base metal temperature is below 0 degrees Fahrenheit, or when the surface is wet or exposed to rain or snow.

(d) An arc shield (ferrule) of heat-resistant ceramic or other material shall be furnished with each stud. The material shall not be detrimental to the welds or cause excessive slag and shall have sufficient strength so as not to crumble or break due to thermal or structural shock before the weld is completed.

(e) Flux for welding shall be furnished with each stud, either attached to the end of the stud or combined with the arc shield for automatic application in the welding operation.

(f) Only qualified studs shall be used. A stud to be qualified shall have passed the tests prescribed in paragraph (i) of this subsection. The arc shield used in production shall be the same as used in the qualification tests.

(g) The Contractor shall submit to the Engineer for approval before installation, information on the studs to be furnished as follows:

1. The name of the manufacturer.
2. A detailed description of the stud and arc shield.
3. A certification from the manufacturer that the stud is qualified as specified in paragraph (i).
4. A copy of the qualification test report as certified by the testing laboratory.

(h) The studs, after welding, shall be free from any defect or substance which would interfere with their functions as shear connectors.

(i) Stud Weldability Qualification Procedure:

1. Purpose. The purpose of this procedure is to prescribe weldability tests that will qualify a shear connector stud for welding under shop or field conditions. The tests may be performed by a testing agency satisfactory to the Engineer.

2. Duration of Qualification. A type and size of stud with arc shield, once qualified, is considered qualified until the manufacturer makes any change in the base of the stud, the flux, or the arc shield which affects the welding characteristics.

3. Preparation of Specimens. (3a) Test specimens shall be prepared by welding representative studs to the

center of square specimen plates, one-half (½) to three-fourths (¾) inch thick, of structural steel, AASHO M 183 (ASTM A36). At the option of the manufacturer, studs may be welded to a large plate and the specimen plates cut to a size suitable for test equipment used.

(3b) Studs shall be welded with power source, welding gun, and control equipment as recommended by the manufacturer. Welding voltage, current and time (see subparagraph 4) shall be measured by suitable instrumentation and recorded for each specimen. Lift and plunge shall be at the optimum setting as recommended by the manufacturer.

4. Number of Test Specimens. (4a) Thirty (30) test specimens shall be welded consecutively with optimum time held constant, but current ten (10) percent above optimum. Optimum current and time shall be the midpoint of the range normally recommended by the manufacturer for production welding.

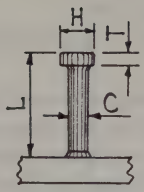
(4b) Thirty (30) test specimens shall be welded consecutively with time held constant at optimum but with current ten (10) percent below optimum.

5. Qualification Tests. (5a) Tensile tests—Ten (10) of the specimens welded in accordance with subparagraph (4a), and ten (10) of the specimens welded in accordance with subparagraph (4b), shall be subjected to a tensile test in a fixture similar to that shown in Figure 2. A stud shall be considered as qualified if all test specimens have a minimum tensile strength of sixty thousand (60,000) psi.

(5b) Bend tests—Twenty (20) of the specimens welded in accordance with subparagraph (4a), and twenty (20) specimens welded in accordance with subparagraph (4b), shall be placed in the bend testing device shown in Figure 3 and bent alternately thirty (30) degrees in opposite directions until failure occurs. A stud shall be considered as qualified if, on all test specimens, fracture occurs in the shank of the stud and not in the weld.

6. Retests. If a weld failure occurs in any of the tensile or bend test groups, that group shall be retested. If failure repeats, the stud shall fail to qualify.

7. Qualification. For a manufacturer's studs and



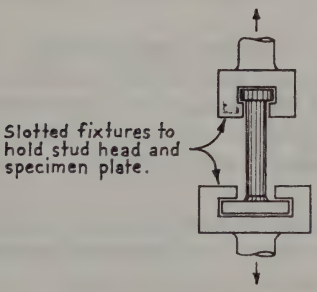
Standard Dimensions

C	L*	H	T
3/4" +.000" -.010"	4" +.062" -.125"	1 1/4" ± 1/64"	3/8" min.
7/8" +.000" -.010"	4" +.062" -.125"	1 3/8" ± 1/64"	3/8" min.

*4" length is standard. Other lengths may be obtained by special order.

DIMENSIONS AND TOLERANCES

Figure 1



TYPICAL TENSILE TEST FIXTURE

Figure 2

arc shields to be qualified, each group of thirty (30) studs shall, by test or retest, meet the requirements prescribed in subparagraphs (5a) and (5b).

8. Report of tests. The laboratory report shall include the following:

(8a) Drawings which show shapes and dimensions with tolerances of studs, arc shields and flux.

(8b) A complete description of materials used in the studs and arc shields, including the quantity and analysis of the flux.

(8c) A certification that the studs and arc shields described in the report are qualified in accordance with paragraph (i) 7.

(j) The first two studs welded on each beam or girder, after being allowed to cool, shall be bent forty-five (45) degrees by striking the stud with a hammer. If failure occurs in the weld of either studs, the procedure shall be corrected and two successive studs successfully welded and tested before any more studs are welded to the beam or girder. The Engineer shall be promptly informed of any changes in the welding procedure at any time during construction.

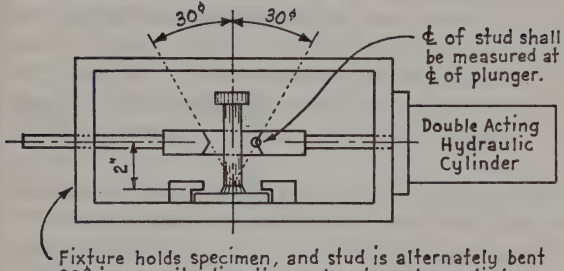
(k) Studs on which a full three hundred sixty (360) degrees weld is not obtained may, at the option of the Contractor, be repaired by adding a three-sixteenths ($\frac{3}{16}$) inch fillet weld in place of the lack of weld, using the shielded metal-arc process with low-hydrogen welding electrodes.

(l) If the reduction in the height of studs as they are welded becomes less than normal, welding shall be stopped immediately and not resumed until the cause has been corrected.

(m) Before welding a new stud where a defective one has been removed, the area shall be ground smooth and flush, or in the case of a pullout of metal, the pocket shall be filled with weld metal using the shielded metal-arc process with low-hydrogen welding electrodes and then ground flush.

(n) Inspection Requirements:

1. After the studs have been welded to the beams a


30°
30°
℄ of stud shall be measured at ℄ of plunger.
Double Acting Hydraulic Cylinder
2"
Fixture holds specimen, and stud is alternately bent 30° in opposite directions. Load can be applied with hydraulic cylinders, as shown, or with fixture adapted for use with tensile testing machine.

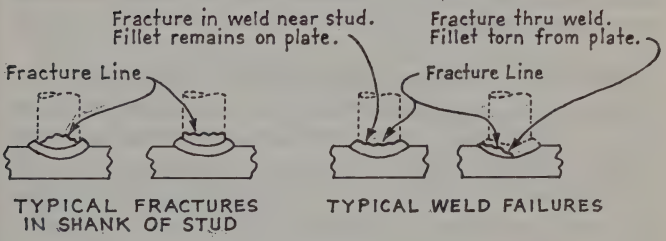

Fracture in weld near stud. Fillet remains on plate.
Fracture Line
Fracture thru weld. Fillet torn from plate.
Fracture Line
TYPICAL FRACTURES IN SHANK OF STUD
TYPICAL WELD FAILURES

Figure 3

visual inspection shall be made and each stud shall be given a light blow with a hammer. Any stud which does not have a complete end weld, any stud which does not emit a ringing sound when given a light blow with a hammer, any stud that has been repaired by welding or any stud which has less than normal reduction in height due to welding, shall be struck with a hammer and bent 15 degrees from the correct axis of installation, and in the case of a defective or repaired weld the stud shall be bent fifteen (15) degrees in the direction that will place the defective portion of the weld in the greatest tension. Studs that crack either in the weld or in the shank shall be replaced.

2. The Engineer, at his option, may select additional studs to be subjected to the bend test specified above.

3. The studs tested that show no sign of failure shall be left in the bent position.

4. If during the progress of the work, inspection and testing indicate the shear connectors are not satisfactory, the Contractor will be required at his expense to make such changes in welding procedure, welding equipment, and type of shear connector as necessary to secure satisfactory results.

506.03.20 Welding. Welding of steel structures when authorized in accordance with the provisions contained herein, called for in the contract documents, or upon written permission from the Engineer shall conform to the requirements of the current specifications for Welded Highway and Railway Bridges of the American Welding Society.

Welds shall be painted according to the applicable provisions of Section 614, "Painting."

All groove welds on primary members shall be finished smooth and flush with the base metal on all surfaces by grinding in the direction of applied stress, leaving surfaces free from depressions. Chipping may be used provided it is followed by such grinding.

506.03.21 Fit of Stiffeners. End stiffeners of girders and stiffeners intended as supports for concentrated loads

shall be milled or ground to secure an even bearing against the flange. Intermediate stiffeners shall fit sufficiently tight to exclude water after being painted. Fillers under stiffeners shall fit within one-fourth (¼) inch at each end.

Welding will be permitted in lieu of milling or grinding if noted in the contract documents. Where stiffeners are required on one side of the web only, they shall be welded to the compression flange.

506.03.22 Annealing and Stress Relieving. Members such as bridge shoes, pedestals, or other parts which are built up by welding sections of plate together, and stress relieving is called for in the contract documents, stress relieving shall be in accordance with the provisions of the American Welding Society.

506.03.23 Pins, Rollers and Pin Holes. Rollers shall be of structural carbon steel, and pins shall be of carbon steel forgings meeting the requirements of subsection 710.03.08, "Pins and Rollers." Pins and rollers shall be accurately turned to the dimensions shown on the drawings and shall be straight, smooth, and free from flaws. Final surface shall be produced by a finishing cut.

In pins larger than nine (9) inches in diameter, a hole not less than two (2) inches in diameter shall be bored full length along the axis after the forging has been cooled to a temperature below the critical range under suitable conditions to prevent injury by too rapid cooling, and before being annealed.

Pin holes shall be bored true to the specified diameter, smooth and straight, at right angles with the axis of the member and parallel with each other unless otherwise specified.

The distance outside to outside of holes in tension members and inside to inside of holes in compression members shall not vary from that specified more than one thirty-second ($\frac{1}{32}$) inch. Boring of holes in built-up members shall be done after the riveting is completed.

The diameter of the pin hole shall not exceed that of the pin by more than one-fiftieth ($\frac{1}{50}$) inch for pins five

(5) inches or less in diameter, or more than one thirty-second ($\frac{1}{32}$) inch for larger pins.

Screw threads for all bolts and pins for structural steel construction shall conform to the American National Coarse Thread Series, Class 2, free fit, except that pin ends having a diameter of one and three-eighths ($1\frac{3}{8}$) inches or more shall be threaded six (6) threads to the inch.

Pilot and driving nuts shall be used in driving pins. They shall be furnished by the Contractor without charge. Two pilot nuts and two drifting nuts for each size of pin shall be furnished, unless otherwise specified. Pins shall be so driven that the members will take full bearing on them. Pin nuts shall be screwed up tight and the threads burred at the face of the nut with a pointed tool.

506.03.24 Shop Painting. Unless otherwise provided the application of shop paints shall conform to the requirements of Section 614, "Painting."

Surfaces to be in contact after shop riveting is completed shall be cleaned but shall not be painted.

506.03.25 Marking and Shipping. Each member shall be painted or marked with an erection mark for identification and an erection diagram shall be furnished with erection marks shown thereon. Members weighing more than three (3) tons shall have the weight marked thereon. Structural members shall be loaded on trucks or cars in such a manner that they may be transported and unloaded at their destination without being excessively stressed, deformed or otherwise damaged. All girders must be shipped in a standing position which position shall be maintained in subsequent operations.

506.03.26 Erection Methods and Equipment. Before starting work, the Contractor shall inform the Engineer fully as to the method of erection he proposes to follow and as to the amount and character of the equipment he proposes to use, the adequacy of which shall be subject to the approval of the Engineer. The approval of the Engineer shall not be considered as relieving the Contractor of the responsibility for the safety and adequacy

of his methods or equipment or from carrying out the work in full accordance with the plans and specifications. No work shall be done without the sanction of the Engineer.

Spot welding for the purpose of eliminating field erection bolts or for holding steel parts together while riveting will not be permitted.

All work of erection shall be subject to inspection and the Contractor shall furnish facilities for such inspection of material and workmanship. Material and workmanship not previously inspected shall be inspected after its delivery to the site of the work.

The Contractor shall provide the falsework and all tools, machinery, and appliances, including drift pins and fitting up bolts necessary for the expeditious handling of the work.

Anchor bolts for rail posts shall be galvanized high-strength bolts set with suitable templates in exact position and securely fixed to prevent displacement during the concreting operations. The areas of concrete upon which posts are to be set shall be dressed by grinding or rubbing to a true plane for the proper seating of the posts. All surfaces of aluminum alloy posts and adjustment shims to be in contact with concrete or with the steel anchor bolts nuts and washers shall be coated with aluminum insulating compound.

Rail posts shall be erected in sections. Erection of sections of rails and posts shall continue successively until all or an approved portion of the required rail is erected. The rail shall then be aligned and the nuts on the anchor bolts tightened. In final adjustment no posts shall deviate more than one-eighth (⅛) inch from true alignment and there shall be no abrupt break in alignment at any location. Aluminum shims may be slotted for ease in placing if approved by the Engineer.

506.03.27 Falsework. The falsework shall be properly designed and substantially constructed and maintained for the loads which will come upon it. The Contractor shall prepare and submit to the Engineer, for approval, plans for falsework or for changes in an existing structure

necessary for maintaining traffic. Approval of the Contractor's plans shall not be considered as relieving the Contractor of any responsibility.

Upon completion of the erection and before final acceptance, the Contractor shall remove all falsework, excavated or useless materials, rubbish and temporary buildings, replace or renew any fences damaged, restore in an acceptable manner all property, both public and private, which may have been damaged during the prosecution of the work, and leave the structure site and adjacent highway in a neat and presentable condition satisfactory to the Engineer.

All excavated material or falsework placed in the stream channel before construction shall be removed by the Contractor before final acceptance.

506.03.28 Bearing and Anchorage. Masonry bearing plates shall not be placed upon bridge seat bearing areas which are improperly finished, deformed, or irregular. Bearing plates shall be set level in exact position and shall have a full and even bearing upon the masonry. Unless otherwise directed by the Engineer, they shall be placed on a layer of canvas and red lead applied as follows: Thoroughly swab the bridge seat bearing area with red lead paint and place upon it three layers of twelve (12) to fourteen (14) ounce duck, each layer being thoroughly swabbed on its top surface with red lead paint. Place the superstructure shoes or pedestals in position while the paint is plastic. As an alternate to canvas and red lead, sheet lead may be used if called for on the plans.

The milled and finished surfaces of castings or bearing plates shall have the shop coat of tallow, white lead, or oil removed immediately prior to placing in the structure. Surfaces designed for sliding movement, one upon the other, shall be given a field coat of graphite grease when placed in the structure.

The Contractor shall drill the holes and set the anchor bolts, except where the holes are formed or the bolts are built into the masonry. The bolts shall be set accurately

and fixed with Portland cement grout, completely filling the holes. The location of the anchor bolts in relation to the slotted holes in the expansion shoes shall correspond with the temperature at the time of erection. The nuts on anchor bolts at the expansion ends of spans shall be adjusted to permit free movement of the span.

Elastomeric bearing pads shall conform to the requirements specified in subsection 502.03.13, "Expansion and Fixed Joints and Bearings."

506.03.29 Field Assembling and Riveting. The parts shall be accurately assembled as shown on the plans and match-marks shall be followed. The material shall be carefully handled so that no part will be bent, broken, or otherwise damaged. Hammering which will injure or distort the members shall not be done. Bearing surfaces and surfaces to be in permanent contact shall be cleaned before the members are assembled. Unless erected by the cantilever method, truss spans shall be erected on blocking so placed as to give the trusses proper camber. The blocking shall be left in place until the tension chord splices are fully riveted and all other truss connections pinned and bolted. Splices of riveted butt joints of compression members, in railings, and in other field splice connections shall have one-half of the connection holes filled with bolts and cylindrical erection pins (half bolts and half pins) before riveting. Splices and connections carrying traffic during erection shall have three-fourths of the holes so filled.

Fitting-up bolts shall be of the same nominal diameter as the rivets, and cylindrical erection pins shall be one thirty-second ($\frac{1}{32}$) inch larger.

Pneumatic hammers shall be used for field riveting. Cup-faced dollies fitting the head closely to insure good bearing shall be used. Connections shall be accurately and securely fitted up before the rivets are driven. Driftings shall be only such as to draw the parts into position and not sufficient to enlarge the holes or distort the metal. Unclear holes shall be reamed or drilled. Rivets shall be heated uniformly to a light "cherry-red" color and shall be

driven while hot. They shall not be overheated or burned. Rivet heads shall be full and symmetrical concentric with the shank and shall have full bearing all around. They shall not be smaller than the heads of the shop rivets. Rivets shall be tight and shall grip the connected parts securely together. Caulking or recupping will not be permitted. In removing rivets, the surrounding metal shall not be injured; if necessary, they shall be drilled out.

Field driven rivets shall be inspected and accepted before being painted.

506.03.30 Misfits. The correction of minor misfits involving nonharmful amounts of reaming, cutting, and chipping shall be considered a legitimate part of the erection. However, any error in the shop fabrication, or deformation resulting from handling and transportation, which prevents the proper assembling and fitting up of the parts by the moderate use of drift pins or by a moderate amount of reaming and slight chipping or cutting, shall be reported immediately to the Engineer and his approval of the method of correction obtained. The correction shall be made in his presence. The Contractor shall be responsible for all misfits, errors, and injuries and shall make the necessary corrections and replacements.

506.03.31 Field Painting. Structural steel, unless otherwise specified shall be painted as specified in Section 614, "Painting."

METHOD OF MEASUREMENT

506.04.01 Measurement. The calculated poundage shown on the plans, plus or minus quantities covered by approved changes, will be the quantity used for payment. The Engineer or the Contractor may request final measurement if a possible error is suspected in the quantities shown on the plans. The Contractor's request for final measurement shall be in writing. Final measurement will be made according to the dimensions shown on the plans plus or minus approved changes, and quantities derived therefrom will be the quantities used for payment.

The calculated weights shall be based on the following assumptions:

(a) Unit weights, pounds per cubic foot:

Iron, malleable	470.0
Iron, wrought	487.0
Steel, rolled, cast, copper bearing, silicon, nickel, and stainless	490.0

The quantity of structural steel measured for payment will be the number of pounds complete and in place.

(b) The weights of rolled shapes and of plates up to and including thirty-six (36) inches in width shall be computed on the basis of their nominal weights and dimensions as shown on the approved shop drawings. To the nominal weights of plates more than thirty-six (36) inches in width, there shall be added one-half of the allowed percentage of overrun in weight as tabulated in ASTM A6. The weight will be computed on the basis of rectangular dimensions for all plates and overall lengths for all structural shapes and with no deductions for copes, clips, sheared edges, punchings, borings, milling, or planing, provided, however, that when parts can be economically cut in multiples from material of larger dimension, the calculated weight shall be taken as that of the material from which the parts can be cut.

(c) The weight of shop rivets will be computed on the basis of reasonable average lengths, in accordance with the following table:

Rivet Diameter (inches)	Pounds Per 100 Rivets
½	20
⅝	30
¾	50
⅞	100
1	150
1⅛	250
1¼	325

(d) To the computed weight of metals may be added 0.4 of 1 percent as an allowance for shop paint.

(e) The weight of weld metal will be computed on the basis of the theoretical volume of the dimensions of the welds. To this weight will be added fifty (50) percent allowance for overrun.

If the proposal contains such an item, standard bridge rail shall be measured in linear feet between concrete posts in the completed work. Measurement will be made to the nearest linear foot of rail for each structure measured along the top of the parapet from concrete end posts to concrete end post.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

506.05.01 Payment. The accepted quantity of structural steel measured as provided in subsection 506.04.01, "Measurement," shall be paid for at the contract unit price bid per pound for structural steel.

The price per pound shall constitute full compensation for doing all the work involved in furnishing, fabricating, delivering, erecting, and painting the steel work in accordance with the details shown on the plans and as herein specified, including furnishing of mill test reports and test specimens, except the specimens for full size tests.

Standard bridge rail shall be paid for at the contract unit price bid per linear foot for standard bridge rail for the type specified whether it be constructed of steel or aluminum. The price per linear foot shall constitute all the work involved in furnishing, fabricating, delivering, erecting, and painting the rail, including the furnishing of mill test reports and test specimens, in accordance with the plans and these specifications.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Structural Steel	Pound
Standard Bridge Rail (type)	Linear Foot

SECTION 507

TIMBER STRUCTURES

DESCRIPTION

507.01.01 General. This item shall consist of furnishing, framing, and installing timber of the kind, sizes, and dimensions and in accordance with the lines, grades, and sections shown on the plans.

MATERIALS

507.02.01 General. Materials shall meet the requirements of the following sections:

Structural and Eyebar Steel	Section 710
Paint	Section 714
Miscellaneous Metals	Section 712
Hardware	Section 723
Timber	Section 718
Timber Preservative	Section 719

If material lists or order lists are sent by the Contractor to the Engineer for checking or approval, such checking or approval by the Engineer shall in no way relieve the Contractor of responsibility for the correctness of such lists. Any expenses incident to the revision of materials furnished in accordance with such lists to make them comply with the design drawings shall be borne by the Contractor.

All framing lumber and structural timber, unless otherwise specified or shown on the plans, shall be Douglas Fir or West Coast Hemlock or Larch.

CONSTRUCTION

507.03.01 Storage of Materials. Lumber and timber on the site of the work shall be stored in piles.

Untreated material shall be open-stacked at least twelve (12) inches above the ground surface and piled to shed water and prevent warping. When required by the Engineer, it shall be protected from the weather by suitable covering.

Treated timber and piling shall be close-stacked and piled to prevent warping.

The ground underneath and in the vicinity of all material piles shall be cleared of all weeds and rubbish.

507.03.02 Workmanship. Workmanship shall be first class throughout. None but competent bridge carpenters shall be employed, and all framing shall be true and exact. Unless otherwise specified, nails and spikes shall be driven with just sufficient force to set the heads flush with the surface of the wood. Deep hammer marks in wood surfaces shall be considered evidence of poor workmanship and sufficient cause for removal of the workman causing them. The workmanship on all metal parts shall conform to the requirements specified in Section 506, "Steel Structures."

507.03.03 Treated Timber. Treated timber and piling shall be carefully handled without sudden dropping, breaking of the outer fibers, bruising, or penetrating the surface with tools. It shall be handled with rope sling. Cant hooks, peaveys, pikes, or hooks shall not be used.

All cutting, framing, and boring of treated timbers shall be done before treatment insofar as is practicable.

All cuts in treated piles or timbers, and all abrasions, after being carfully trimmed, shall be covered with two applications of a mixture of sixty (60) percent creosote oil and forty (40) percent roofing pitch, or brush coated with at least two applications of hot creosote oil and covered with hot roofing pitch.

All bolt holes bored after treatment, shall be treated with creosote oil by means of an approved pressure bolt hole treater. Unfilled holes, after being treated with creosote oil, shall be plugged with creosoted plugs.

Whenever, with the approval of the Engineer, forms or temporary braces are attached to treated timber with nails or spikes, the hole shall be filled by driving galvanized nails or spikes flush with the surface or plugging holes as required for bolt holes.

507.03.04 Untreated Timber. In structures of untreated timber the following surfaces shall be thoroughly coated with two coats of hot creosote oil before assembling: Ends, tops, and all contact surfaces of sills, caps, floors, and stringers; and all ends joints and all contact surfaces of bracing and truss members. The back faces of bulkheads and all other timber which is to be in contact with earth, metal, or other timber shall be similarly treated.

Unless untreated timber is to be used in the construction within three (3) days after date of delivery, it shall be painted on each end with a prime coat at time of delivery.

507.03.05 Holes for Bolts, Dowels, Rods, and Lag Screws. Holes for round drift-holes and dowels shall be bored with a bit one-sixteenth ($\frac{1}{16}$) inch less in diameter than the bolt or dowel to be used. The diameter of holes for square drift-bolts or dowels shall be equal to the least dimension of the bolt or dowel.

Holes for machine bolts shall be bored with a bit of the same diameter as the bolt.

Holes for rods shall be bored with a bit one-sixteenth ($\frac{1}{16}$) inch greater in diameter than the rod.

Holes for lag screws shall be bored with a bit not larger than the body of the screw at the base of the thread.

507.03.06 Bolts and Washers. A washer of the size and type specified shall be used under all bolt heads and nuts which would otherwise come in contact with wood.

The nuts of all bolts shall be effectively locked after they have been finally tightened.

Countersinking shall be done whenever smooth faces are required. Horizontal recesses formed for countersinking shall be painted with hot creosote oil, and after the bolts are screwed in place, shall be filled with hot pitch.

507.03.07 Framing. All lumber and timber shall be accurately cut and framed to a close fit in such manner that the joints will have even bearing over the entire contact surfaces. Mortises shall be true to size for their full

depth and tenons shall fit snugly. No shimming will be permitted in making joints, nor will open joints be accepted.

Mud sills shall be firmly and evenly bedded to solid bearing and tamped in place.

Concrete pedestals for the support of framed bents shall be carefully finished so that the sills or posts will take even bearing on them. Dowels of not less than three-fourths (¾) inch diameter and projecting at least six (6) inches above the tops of the pedestals, shall be set in them when they are cast, for anchoring the sills or posts.

Sills shall have true and even bearing on mud sills, piles, or pedestals. They shall be drift-bolted to mud sills or piles with bolts of not less than three-fourths (¾) inch diameter and extending into the mud sills or piles at least six (6) inches. When possible, all earth shall be removed from contact with sills so that there will be free air circulation around them.

Posts shall be fastened to pedestals with dowels of not less than three-fourths (¾) inch diameter, extending at least six (6) inches into the posts.

Posts shall be fastened to sills by one of the following methods, as indicated on the plans:

(a) By dowels of not less than three-fourths (¾) inch diameter, extending at least six (6) inches into posts and sills.

(b) By drift-bolts of not less than three-fourths (¾) inch diameter driven diagonally through the base of the post and extending at least nine (9) inches into the sill.

507.03.08 Caps. Timber caps shall be placed to secure an even and uniform bearing over the tops of the supporting posts or piles and to secure an even alignment of their ends. All caps shall be secured by drift-bolts, as indicated on the plans, extending at least nine (9) inches into the posts or piles. Drift-bolts shall be approximately in the center of the post or pile.

507.03.09 Bracing. The ends of bracing shall be bolted through the pile, post or cap with a bolt of not less

than five-eighths (⅝) inch diameter. Intermediate intersections shall be bolted, and spiked with wire or boat spikes, as indicated on the plans. In all cases spikes shall be used in addition to the bolts.

507.03.10 Stringers. Stringers shall be sized at bearings and shall be placed in position so that knots near edges will be in the top portions of the stringers.

Outside stringers may have butt joints with the ends cut on a taper, but interior stringers shall be lapped to take bearing over the full width of the floor beam or cap at each end. The lapped ends of untreated stringers shall be separated at least one-half (½) inch for the circulation of air and shall be securely fastened by drift-bolts where specified. When stringers are two panels in length the joints shall be staggered.

Cross-bridging between stringers shall be neatly and accurately framed and securely toe-nailed with at least two nails at each end. All cross-bridging members shall have full bearing at each end against the sides of stringers. Unless otherwise specified in the contract, cross-bridging shall be placed at the center of each span.

507.03.11 Plank Floors. Unless otherwise specified, flooring plank shall be surfaced one side and one edge. Single plank floors shall consist of a single thickness of plank supported by stringers or joists. The plank shall be laid heart side down with one-fourth (¼) inch openings between them for locally seasoned material and with tight joints for unseasoned material. Each plank shall be securely spiked to each joist. The plank shall be carefully graded as to thickness and so laid that no two adjacent planks will vary in thickness more than one-sixteenth ($\frac{1}{16}$) inch.

Two-ply timber plank floors shall consist of two layers of flooring supported on stringers or joists. The lower course shall be pressure-treated with a creosote oil. The top course may be laid either diagonal or parallel to the centerline of the roadway, as specified, and each floor piece shall be securely fastened to the lower course. Joints shall

be staggered at least three (3) feet. If the top flooring is placed parallel to the centerline of the roadway, special care shall be taken to securely fasten the ends of the flooring. At each end of the bridge these members shall be beveled.

507.03.12 Laminated Floors. Laminated floors shall be composed of three (3) by six (6) inch or two (2) by six (6) inch timbers, as indicated on the plans, laid on edge at right angles to the centerline of the roadbed, unless otherwise shown on the plans.

The flooring may be of random length and multiples of the stringer spacing with no single piece less than six (6) feet long. All splices shall be made on the centerline of a stringer and shall not occur oftener than once in six (6) inches on any one stringer.

Laminations shall be laid with a finished edge down. Before laying, the tops of stringers shall be checked with a straightedge and adjacent stringers which vary more than one-eighth (⅛) inch from a true plane, except treated stringers, shall be surfaced to meet this requirement. Treated stringers which do not meet the requirements may be rejected but shall not be framed or adzed after treatment. Each piece of flooring shall be fastened to the preceding strip at each end and at approximately eighteen (18) inch intervals with spikes or nails driven alternately near the top and bottom edges. Spikes or nails shall be of sufficient length to pass through two strips and at least halfway through the third strip. If timber supports are used, each piece shall be toe-nailed to every other support with 20d or 30d nails. Care shall be taken to have each strip vertical and tight against the preceding one, and bearing evenly on all supports.

507.03.13 Trusses. Trusses, when completed, shall show no irregularities of line. Chords shall be straight and true from end to end in horizontal projection, and in vertical projection, shall show a smooth curve through panel points conforming to the correct camber. All bearing surfaces shall fit accurately. Uneven or rough cuts at the points of bearing shall be cause for rejection of the piece containing the defect.

Unless otherwise directed by the Engineer, housings and railings shall be built after the removal of the falsework and the adjustment of the trusses to correct alignment and camber.

507.03.14 Painting. Outside stringers, wheel guards, rails, rail posts, and exposed surfaces of scupper blocks, filler blocks, and flooring of untreated timber, or timber treated with preservative salts, shall be painted as specified in Section 614, "Painting."

Ends of all pieces of untreated timber not otherwise painted shall be painted with one prime coat.

Metal parts, except hardware, shall be painted as specified in Section 614, "Painting," and given the number of coats specified in subsection 714.03.01(b), "Miscellaneous Iron."

METHOD OF MEASUREMENT

507.04.01 Measurement. The quantity of timber and lumber to be measured for payment will be the number of thousand feet board measure (Mfbm) conforming to all the requirements in the completed work.

All measurements will be in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

507.05.01 Payment. The accepted quantity of materials measured as provided in subsection 507.04.01, "Measurement," will be paid for at the contract unit price bid per thousand feet board measure (Mfbm).

The above prices shall be full compensation for furnishing all materials, including hardware, treating, erecting, and for all incidentals necessary for doing all the work involved, as shown on the plans or established by the Engineer, all in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Type Lumber	Mfbm

SECTION 508

PILING

DESCRIPTION

508.01.01 General. This work shall consist of furnishing and driving bearing piles of the kind, shape, and size called for in the contract documents. It includes timber piles, precast or cast in place concrete piles, sheet piling, and steel piles as described herein and is also applicable to other types of bearing piles if called for in the contract documents.

MATERIALS

508.02.01 General. Materials shall conform to the requirements of the following sections:

Steel Shell for Piles	Subsection 712.03.08
Steel Piles ("H" piles, sheet piling)	Subsection 712.03.07
Reinforcement	Section 713
Timber Piles	Section 717

Materials for concrete shall conform to the requirements of Section 501, "Portland Cement Concrete."

The Contractor shall furnish the Engineer with copies of mill test reports on the steel shells and steel piles.

CONSTRUCTION

508.03.01 Determination of Length. Bearing piles of any material shall be of such length as is required to develop the specified bearing value, to obtain the specified penetration, and to extend into the cap or footing block as indicated on the plans, after cutoff of any damaged portion.

The Contractor shall be responsible for furnishing piling of sufficient length to obtain the penetration and bearing value required. For the purpose of determining the lengths of the piles required, the Contractor, at his expense, may drive test piles, make borings or make such other investigations as may be necessary.

508.03.02 Test Piles. Test piles furnished and driven by the Contractor for his use in determining the lengths of piles to be furnished may be so located that they may be cut off and become a part of the completed structure provided that such test piles conform to the requirements for piling as specified in these specifications.

Test piles which are designated in the contract documents shall conform to the requirements for piling as specified in these specifications and shall be so located that they may be cut off and become a part of the completed structure.

Test piles that are to become a part of the completed structure shall be driven with the same type of equipment that is to be used for driving foundation piles.

Test piles which are not to be incorporated in the completed structure shall be removed to at least two (2) feet below the surface of the ground and the remaining hole shall be backfilled with earth or other suitable material.

When piles are shown on the plans or specified in the special provisions to be load tested, such piles shall be load tested in accordance with the provisions in subsection 508.03.07, "Load Testing."

508.03.03 Equipment. The driving equipment shall be in good operating condition.

The size of hammer shall be selected to suit the conditions that will be encountered. It shall neither be so small that its energy will be largely dissipated in lost energy during driving nor so great that it will cause too rapid penetration and damage to the pile. If the size of the hammer used is found to be unsatisfactory, it shall be replaced with a larger or smaller hammer or other corrective measures shall be used as required to produce satisfactory results.

All piles shall be driven with either single or double acting steam, air or diesel hammers.

Precast concrete piles shall be driven with a steam, air or diesel hammer which shall develop an energy per blow at each full stroke of the piston of not less than one (1) foot-pound for each pound of weight driven.

For cast-in-place concrete piles where a mandrel is used in driving the shell, the total weight of the mandrel and the

shell shall be considered as the weight of the pile and the hammer shall meet the same requirements as for precast concrete piles.

Hammers for driving H-bearing steel piles and steel shells for cast-in-place concrete piles, which are driven without mandrel, shall be steam, air, or diesel hammers of sufficient capacity to drive the pile or shell to the required penetration and bearing value without appreciable distortion or distress to the pile or shell.

Steam or air hammers shall be furnished with boiler or air capacity at least equal to that specified by the manufacturers of the hammers to be used. The boiler or compressor shall be equipped with an accurate pressure gauge at all times. The valve mechanism and other parts of the steam or air hammer shall be maintained in first-class condition so that the length of stroke and number of blows per minute for which the hammer is designed will be obtained. Inefficient steam or air hammers shall be removed from the work. When necessary to obtain the required penetration, the Contractor shall supply and operate at his own expense, single or double water jets and pumps or furnish the necessary drilling apparatus and drill holes not greater than the diameter of the pile to the proper depth and drive the piles therein. If a pile is set in a drilled hole, it shall be driven sufficiently to fix the point firmly and secure full bearing. Except as described in subsection 508.03.04, "Driving of Piles," jets or drills may be used only when so specified or ordered in writing by the Engineer.

Diesel-powered hammers may be used provided the required energy per blow, as specified for steam hammers, is delivered for the type of piling to be driven.

Driving leads shall be used and shall be constructed in such a manner as to afford freedom of movement of the hammer, and they shall be held in position by guys or stiff braces to insure support to the piles during driving. Except where piles are driven through water, the leads shall be of sufficient length so that the use of a follower will not be necessary.

508.03.04 Driving of Piles. Unless otherwise permitted by the Engineer, piles shall not be driven until after

the excavation is completed. Any material forced up between the piles shall be removed to correct elevation before masonry for the foundation is placed.

Care shall be exercised to prevent damage to the piles due to overdriving.

Piles shall be driven battered (sloped) if called for on the plans.

Piles, other than sheet piles, shall not be driven until the approach fills are compacted and in place to an elevation of one and one-half (1½) feet above the bottom of the concrete abutment, as indicated on the plans. When piles are to be driven through embankment and the depth of the embankment at the pile location is in excess of five (5) feet, the pile (other than sheet pile) shall be driven in a hole drilled through the embankment. The hole shall have a diameter large enough to allow a minimum of two (2) inch clearance around the pile. After driving the pile, the space around the pile shall be filled to ground surface with dry sand or pea gravel.

When an abutment area is to be surcharged, piles shall not be driven therein until the surcharge has been in place the required period of time.

All piles raised during the process of driving adjacent piles shall be driven down again.

Unless otherwise ordered, inclined leads shall be used in driving battered piles.

An adequate cushion cap shall be used in driving precast concrete piles. When driving timber piles a cushion cap shall be used and not less than two separate steel straps shall be placed within two feet of the butt of each pile. Steel strapping shall conform to the requirements of A.W.P.I. specifications, except that the straps shall encircle the pile only once per strap. The top of the pile and the cap shall be so shaped that the blow of the hammer will be uniformly distributed to the entire top surface of the pile.

When load tests are required, piling shall not be driven until after test loading has been completed, except in case of service piles driven to serve as anchor piles for the test loading.

If the top of a pile becomes broomed, split, or crushed

during the driving, the driving shall be stopped until the pile has been repaired or replaced by a new one.

The driving heads shall closely fit the top of the steel pile or shall extend down over the sides of the pile at least four (4) inches.

Piles shall be driven to the position and line indicated on the plans. Piles out of position and line more than the diameter of the pile, shall be pulled and replaced unless otherwise approved by the Engineer. When the tops of foundation piles are incorporated in a concrete footing, the distance from the side of any pile to the nearest edge of the footing shall not be less than nine (9) inches. Any additional materials required because of out-of-line piles that are allowed to remain in place will be at the expense of the Contractor.

508.03.05 Bearing Value and Penetration. Piles shall be driven to a bearing value of not less than the design loading shown on the plans, and in addition shall penetrate at least to the specified tip elevation shown on the plans at any location where a specified tip elevation is shown, unless otherwise permitted in writing by the Engineer; or shall penetrate at least ten (10) feet into the natural ground when a tip elevation is not specified, unless a lesser penetration is approved by the Engineer.

Natural ground in any area or highway embankment shall be defined as the bottom of the highway embankment.

When the pile design loading is omitted from the plans, timber, steel, and concrete piles shall be driven to bearing values equal to the Maximum Design Loads for Piles, specified in the Standard Specifications for Highway Bridges of the AASHO. The bearing values for driven piles shall be determined from the following formula:

$$P = \frac{2E}{S + 0.1}$$

P=Safe bearing value in pounds.
E=The energy of the hammer blow in foot-pounds.
For drop hammers and single acting steam hammers, E=WH, where W is the weight of the striking parts of

the hammer in pounds, and H is the height of fall of the striking parts in feet.

For double acting or differential steam hammers, E= The manufacturer's rated energy in foot-pounds.

For diesel hammers, E will be determined by the Engineer.

S=The average penertation in inches per blow for the last five to ten blows.

The above formula is applicable only when:

(a) The hammer has a free fall.

(b) The head of pile is not damaged.

(c) The penetration is reasonably quick and uniform.

(d) A follower is not used.

Twice the height of bounce shall be deducted from H to determine its value in the formula.

If the weight of the pile and the driving cap and all parts driven is greater than the weight of the striking parts of the hammer, the formula shall be multiplied by the factor $\frac{2W}{W + P}$ where P is the weight of the pile and cap.

In case jets are permitted in connection with the driving, the bearing power shall be determined by the above formula from results after the jets have been withdrawn.

508.03.06 Cutoff and Extensions. Timber piles which are to be capped shall be accurately cut off so that true bearing is obtained on every pile without use of shims. Other timber piles shall be cut off on the square at the elevation designated. Piles inaccurately cut off shall be replaced. Splicing of timber piles will not be permitted except upon the written permission of the Engineer. Concrete piles shall be cut off at such elevation that they will extend into the cap or footing as indicated on the plans. Concrete piles may be cast the full length of the reinforcing bars, providing that the concrete is cut off to expose the steel as shown on the plans after the piles have been driven. When it is necessary, after driving, to increase the length of precast concrete piles, concrete shall be removed to expose sufficient reinforcing steel to permit a lap of at least forty diameters. The added length shall be sufficient to reach the elevation of the bottom of the cap and shall

be of the same section and the same reinforcement as the pile itself.

When the cutoff elevation for precast concrete pile is below the elevation of the bottom of the cap, the pile shall be built up from the butt of the pile to the elevation of the bottom of the cap by means of a reinforced concrete extension constructed as shown on the plans.

The work of cutting off precast concrete piles shall be performed in such a manner as to avoid spalling or damaging the pile below the cutoff. In case of such damage the pile shall be replaced or repaired as required by the Engineer.

All cutoff lengths of piling shall remain the property of the Contractor and shall be disposed of outside the highway right of way in accordance with the provisions of subsection 107.14, "Disposal of Material Outside Highway Right of Way."

508.03.07 Load Testing. The number and location of the load tests shall be noted on the plans.

The Contractor shall submit detailed plans of his proposed testing methods to the Engineer for approval.

Load tests shall be applied in the manner shown on the plans and shall consist of the application of a test load by means of a hydraulic jack equipped with an accurate calibrated pressure gage reading in pounds per square inch or tons of total load, so arranged as to apply and maintain the required test load for a period of forty-eight (48) hours, or more, and equipped with a device for measurement of the settlement of the pile under each increment of load. The jack capacity shall be at least three (3) times minimum bearing value of the piles.

The test load shall be applied in increments of ten (10) tons until a total load of twice the design bearing value has been reached.

Two measurements of settlement shall be taken after each increment of load, one immediately after applying load and the other after the load has been maintained for ten (10) minutes.

The safe allowable design load shall be considered as fifty (50) percent of that load which after a continuous

application of forty-eight (48) hours produces a total permanent settlement not to exceed one-fourth (¼) inch, measured at the top of the pile and providing a settlement not exceeding one hundredth (0.01) of an inch has taken place in the last eight (8) hours. The load shall then be reduced in decrements of ten (10) tons, measuring recovery after each decrement of load until no load remains.

Another load shall then be applied in increments of ten (10) tons, taking two measurements of settlements after each increment of load as noted above until the maximum capacity of the pile is reached or until the maximum capacity of the testing apparatus is reached. The load shall then be reduced in decrements of ten (10) tons, measuring the recovery after each decrement. When cast-in-drilled hole piles are used, this second loading to the capacity of testing apparatus will not be required.

508.03.08 Timber Piles. The specie of timber used for timber piles shall be either Douglas Fir, Southern Yellow Pine, Larch, or Cedar as shown in the contract documents.

When treated piles are required they shall be given a preservative treatment of creosote by pressure processes to retain at least ten (10) pounds of creosote per cubic foot.

Timber piles shall conform to the requirements of Section 717, "Timber Piles," and shall be inspected as therein provided.

Commercially treated piles from stock may be used for test piles when required. Where commercially treated piles are permitted, stamping the piles by the inspector before treatment will not be required.

Treated timber piles shall be carefully handled during and after unloading from cars. They shall not be dragged across the ground at any time and shall be handled only with rope slings or with wooden equipment. Sharp tools shall be permitted only when used for necessary field cutting and trimming. All places where the surface of creosoted piling is broken by cutting, boring, or otherwise, shall be thoroughly coated with at least three applications

of hot creosote oil. Each application shall be allowed to become reasonably dry before the succeeding one is applied.

The piles in any one bent shall be carefully selected as to size, to avoid undue bending or distortion of the sway bracing. However, care shall be exercised in the distribution of piles of varying sizes to secure uniform strength and rigidity in the bents of any given structure.

Heads of piles, when the nature of the driving is such as to unduly injure them, shall be protected by caps of approved design.

When timber caps are specified, a coat of hot creosote oil shall be first applied to the head of the pile and a protective cap shall be built up by applying alternate layers of loosely woven fabric in a hot asphalt or tar using three layers of asphalt or tar and two layers of fabric. The fabric shall measure at least six (6) inches more in each direction than the diameter of the pile and shall be turned over the pile and the edges secured by binding with two turns of No. 10 galvanized wire. The fabric shall be wired in advance of the application of the final coat of asphalt or tar which shall extend down over the wiring.

In lieu of the above method of treatment, the sawed surface may be covered with three applications of a hot mixture of sixty (60) percent creosote oil and forty (40) percent roofing pitch, or thoroughly brush coated with three applications of hot creosote oil and covered with hot roofing pitch. A covering of galvanized sheet iron shall be placed over the pitch coating and bent down over the sides of the pile to shed water.

The method to be used shall be at the option of the Contractor unless otherwise provided on the plans or in the special provisions.

508.03.09 Precast Concrete Piles. Precast concrete piles shall be constructed of Class A or AA Portland cement concrete proportioned and mixed in accordance with the requirements of Section 501, "Portland Cement Concrete" and placed in accordance with Section 502, "Concrete Structures" of these specifications. Reinforcing

steel shall conform to the requirements of Section 505, "Reinforcing Steel" of these specifications.

Concrete for precast concrete piles shall be poured in smooth watertight forms, so supported as to prevent appreciable deformation or settlement during pouring or curing. When removed from the form, the piles shall present true, smooth even surfaces free from honeycombs and voids and shall be such that a line stretched from butt to tip on any face will not be more than one (1) inch from the face of the pile at any point.

Concrete piles shall be kept continuously wet for at least ten (10) days after pouring and shall be allowed to harden for at least thirty (30) days before being lifted or driven, except that this thirty (30) day requirement may be decreased if the specimen of concrete from which the piles were poured develops a strength of three thousand (3,000) pounds or more per square inch of compression.

When raising or transporting precast concrete piles, the Contractor shall provide slings or other equipment to avoid any appreciable bending of the pile or cracking of the concrete. Piles materially damaged in handling or driving shall be replaced. Concrete piles shall be so handled at all times as to avoid breaking or chipping of the edges.

508.03.10 Cast-In-Place Concrete Piles. Concrete filling for cast-in-place concrete piles shall be Class A or AA Portland cement concrete conforming to the requirements of Section 501, "Portland Cement Concrete" of these specifications. Reinforcement shall conform with the details shown on the plans and the requirements of Section 505, "Reinforcing Steel." Cast-in-place concrete piles shall consist of one of the following: Steel shells driven permanently to the required bearing value and filled with concrete; or, drilled holes filled with concrete.

(a) Steel shells shall be of sufficient strength and rigidity to permit their driving and to prevent distortion caused by soil pressures or the driving of adjacent piles until filled with concrete. The shells shall also be sufficiently watertight to exclude water during the placing of concrete.

The shells may be cylindrical or tapered, step tapered, or a combination of either with cylindrical sections. The tip diameter shall not be less than eight (8) inches and the butt diameter shall not be less than shown on the plans.

Shells to be driven without a mandrel shall be equipped with heavy steel driving ends and all joints in the shell shall be welded or adequately lock seamed.

After being driven and prior to placing concrete and reinforcing steel therein, the steel shells or casings shall be examined for collapse or reduced diameter at any point. Any shell or casing that is improperly driven or broken or shows partial collapse to such an extent as to materially decrease its bearing value will not be accepted and shall be replaced by the Contractor at his own expense. Driven shells or casings shall be clean and free from water before concrete and reinforcing steel are placed. The Contractor shall have available at all times a suitable light for the inspection of the shells, throughout the entire length, before they are filled with concrete and reinforcing steel.

Concrete shall be placed in steel shells so that it is dense and homogeneous. The upper portion of the shell shall be vibrated to a depth of not less than one third the length of the pile or ten (10) feet, whichever is the greater.

(b) Except for a minimum amount of water necessary for penetration of the drill, all holes for concrete piles cast in drill holes shall be drilled dry to the tip elevation shown on the plans or to the elevation determined by the Engineer. No standing water in the bottom of hole, after final drilling, will be permitted. All holes shall be examined for straightness and any hole which on visual inspection from the top shows less than one-half the diameter of the hole at the bottom of the hole shall be rejected. Suitable casings shall be furnished and placed when required to prevent caving of the hole before concrete is placed therein.

All loose material existing at the bottom of the hole after drilling operations have been completed shall be removed or compacted to the satisfaction of the Engineer before placing concrete in the hole.

Materials resulting from drilling holes shall be disposed of as provided in the last paragraph of subsection 206.-03.01, "General."

Surface water shall not be permitted to enter the hole and all water which may have infiltrated into the hole shall be removed before placing concrete therein.

Casing, if used in drilling operations, shall be removed from the hole as concrete is placed therein. The bottom of the casing shall be maintained not more than five (5) feet nor less than one (1) foot below the top of the concrete during withdrawal and placing operations unless otherwise permitted by the Engineer. The casing shall be hammered or the concrete vibrated during withdrawal of the casing.

Care shall be exercised to insure that the concrete in the hole is dense and homogeneous. Vibration of the concrete during placing will not be required. The concrete in the hole for the length of the reinforcing cage (bottom of spiral wire) shall be vibrated.

The reinforcing cage shall be placed and secured symmetrically about the axis of the pile and shall be securely blocked to clear the sides of the hole.

For either (a) or (b) the bottom of each shell casing or hole shall be filled with mortar to a depth of not less than two (2) feet immediately before placing the concrete filling materials. The mortar shall consist of one part Portland cement, three parts fine aggregate mixed to a suitable consistency or Class A or AA concrete with three-fourths (¾) inch or larger aggregate removed.

508.03.11 Steel Piles. Steel piles shall be H-bearing of the section shown on the plans.

The length of steel pile may be built up in sections either before or during the driving operations. The sections, unless otherwise shown on the plans, shall be identical in cross section. The connections shall be made by welding the entire cross section in conformance with the requirements of subsection 506.03.20, "Welding." Care shall be taken to properly align the sections connected so that axis of the pile will be straight. The number of welded connections in the length of a pile shall be preferably as few

as practicable. If a welded splice is made during the driving operation, it shall be done when the top of the lower portion is at least three (3) feet above the ground to permit observation of the welded connection during several feet of driving.

When necessary, splices shall be performed in accordance with the standard sheet appended to the plans.

METHOD OF MEASUREMENT

508.04.01 Measurement. The quantity of "Furnish (Type) Piles" to be measured for payment will be the number of linear feet of (type) pile complete and in place measured from the tip of the pile to the plane of pile cutoff.

The quantity of "Driving (Type) Piles" to be measured for payment will be the number of piles driven in place.

If the Contractor casts concrete piles full length of the reinforcement bars to facilitate driving, no measurement will be made for that portion where concrete must be removed in order that bars may project as shown on the plans.

Load tests will be measured per each and the number used in the work will be the number paid for.

The quantity of splices to be measured for payment will be the number of splices actually made in the work; limited, however, for the purposes of measurement and payment, to one per timber pile and two per steel pile.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

508.05.01 Payment. The accepted quantity of "Furnish (Type) Piles," measured as provided in subsection 508.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot, which price shall be full compensation for furnishing all materials including Portland cement concrete, steel shells and reinforcing steel, placing filling materials, and disposing of all unused material.

The accepted quantity of "Driving (Type) Piles" measured as provided in subsection 508.04.01, "Measurement,"

will be paid for at the contract unit price bid per each, which price shall be full compensation for doing all the work involved in driving, drilling holes, cutting off piles, excavation and backfill, and for filling the space remaining around the pile with sand or pea gravel; all to the required bearing and penetration as shown on the plans or ordered by the Engineer. No additional compensation over the contract price for "Driving (Type) Piles" will be made for driving piles additional lengths over those lengths anticipated by the total number of linear feet of pile shown in the proposal.

Test piles that become a part of the completed structure will be paid for at the contract prices for the type of piling used.

No payment will be made for piles driven out of place or for imperfect piles, or for piles which are damaged in handling or driving.

When, in addition to the requirements of the plans and specifications, brackets or plates are required on steel piles, or special driving shoes are required on timber piles, the Contractor shall furnish and place such devices and the cost thereof will be paid for as extra work as provided in subsection 104.03, "Extra Work."

The accepted quantity of load tests measured as provided in subsection 508.04.01, "Measurement," will be paid for at the contract unit price bid per each for load tests, which price shall be full compensation for all material, equipment, tools, and labor incidental to make the tests and to construct the loading platform, procuring and placing the loading material, and removing and disposing of platform material in a satisfactory manner.

The accepted quantity of splices measured as provided in subsection 508.04.01, "Measurement," will be paid for at the contract unit price bid per each for the splice, which price shall be full compensation for all material, equipment, tools, and labor incidental to make the splice.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Furnish (type) Piles	Linear Foot
Drive (type) Piles	Each
Load Test	Each
Splices	Each

SECTION 601

PIPE CULVERTS—GENERAL

DESCRIPTION

601.01.01 General. These specifications include general requirements that are applicable to all type culvert pipes except structural plate pipe, irrespective of the material or culvert use.

This work shall consist of furnishing and installing pipe culverts, siphons, end sections, end walls, etc., as may be required to complete the work shown on the plans or established by the Engineer.

MATERIALS

601.02.01 General. The materials used shall be those prescribed or used for the several items which constitute the finished work and shall conform to the requirements in the following subsections:

Corrugated Metal Pipe and Pipe Arches	Subsection 709.03.01
Bituminous Coated Corrugated Metal Pipe and Pipe Arches	Subsection 709.03.02
Corrugated Aluminum Pipe	Subsection 709.03.03
Reinforced Concrete Pipe	Subsection 708.03.01
Nonreinforced Concrete Pipe	Subsection 708.03.02
Clay Pipe	Subsection 708.03.04
Grout and Mortar Sand	Subsection 706.03.04
Rubber Gaskets	Subsection 707.03.02

When the location of manufacturing plants allows, the plants will be inspected periodically for compliance with specified manufacturing methods, and material samples will be obtained for laboratory testing for compliance with materials quality requirements. This can be the basis for acceptance of manufacturing lots as to quality.

All materials will be subject to inspection for acceptance as to condition at the latest practicable time the Engineer has the opportunity to check for compliance prior to or during incorporation of materials in the work.

The lengths shown on the plans are approximate. The Contractor shall not order and deliver the culvert pipe until a list of sizes and lengths is furnished him by the Engineer.

For structural plate pipe and arches, attention is directed to Section 606, "Structural Plate Pipe, Pipe Arch, and Arch Culverts."

CONSTRUCTION

601.03.01 Earthwork. Excavation and backfill shall conform to the requirements of Section 206, "Structure Excavation" and 207, "Backfill."

The pipe shall be bedded as shown in the standard sheets appended to the plans. When no bedding class is specified, the requirements for Class C bedding shall apply. The lines and grades will be established by the Engineer.

Where pipes are to be installed in new embankments on a steep slope or in a difficult location, the height of new embankments may be varied as directed by the Engineer before installing pipes.

When headwalls are not required and granular materials are used for backfilling, the fill at the ends of the structure shall be sealed against the infiltration of water by bedding the ends of the structure in well tamped clay as shown on the plans.

601.03.02 Headwalls. Where shown on the plans, inlet and outlet headwalls shall be constructed or installed in connection with culvert pipes. Where such headwalls are constructed or installed, the ends of pipes shall be placed flush or cut off flush with the headwall face, unless otherwise permitted by the Engineer. Headwalls are to be constructed to conform to the applicable requirements of Sections 501, "Portland Cement Concrete" and 502, "Concrete Structures."

601.03.03 End Sections. The bed for the end section shall be excavated to the required width and grade. For metal end sections with toe plates, a trench shall be excavated for the toe plate in a manner to permit the toe plate being against the inner face of the trench when the end section is in its final position. After end sections have been properly secured to the pipe, this trench shall be backfilled and firmly compacted.

Precast concrete end section shall be placed with its

tongue (or groove) fully entered in the groove (or tongue) of the pipe.

601.03.04 Jacked Pipes. Culvert pipe to be jacked in place between the limits shown on the plans shall conform to the requirements of the respective section of pipe culverts.

The strength of pipe or gage of pipe will be determined for vertical load only. Any additional reinforcement or strength required to withstand jacking pressure shall be determined and furnished by the Contractor at his expense.

Variation from theoretical alignment and grade at the time of completion of placing shall not exceed 0.2 foot for each twenty (20) feet of pipe placed.

The diameter of the excavated hole shall not be more than 0.1 foot greater than the outside diameter of the pipe. Sluicing and jetting with water will not be permitted. When the material tends to cave in from outside these limits a shield shall be used ahead of the first section of pipe or the face of excavation shall not extend beyond the end of the pipe greater than one and one-half (1½) feet unless permitted by the Engineer.

Areas resulting from caving or excavating outside the above limits shall be backfilled with sand or grout by a method which will fill the voids.

601.03.05 Laying Culvert Pipe. Laying of culvert pipe shall conform to the requirements of the respective sections of culvert pipe.

601.03.06 Extending Existing Culverts. Where shown on the plans or directed by the Engineer, existing culverts shall be extended in accordance with the provisions for installing new culverts and the following additional provisions.

Existing headwalls shall be demolished and removed and disposed of or moved to the extended location as indicated on the plans or ordered by the Engineer. Attention is directed to Section 202, "Removal of Structures and Obstructions."

A headwall that is not to be reset shall be demolished

without injury to the existing culvert and removed and disposed of in accordance with the provisions of Section 202, "Removal of Structures and Obstructions." If shown on the plans or ordered by the Engineer, a new concrete headwall shall be constructed in accordance with the provisions of Section 501, "Portland Cement Concrete" of these specifications, or a flared end section shall be attached thereto.

METHOD OF MEASUREMENT

601.04.01 Measurement. The materials to be paid for under these specifications will be listed in the contract items by size, class, type gage, or whatever information is necessary for identification.

The quantity of culvert pipe to be measured for payment will be the actual number of linear feet of pipe exclusive of end sections, complete and in place. When pipes are cut to fit a structure or slope, the quantity to be paid for will be the length of pipe necessary to be placed before cutting, measured in even two (2) foot increments.

Culvert pipe bends, wyes, tees, and other branches will be measured and paid for by the linear foot for the sizes of pipes involved. Wyes, tees, eccentric reducers, and other branches will be measured along centerlines to the point of intersection.

Structure excavation and structure backfill, Portland cement concrete and reinforcement required for headwalls, endwalls, structures, and other items of work required by the plans and special provisions to complete the work, will be measured and paid for as separate items as provided for under their respective sections of these specifications, or the contract documents. Structure excavation and backfill will not be measured for payment on preformed end sections.

No separate measurement or payment will be made for constructing jacking pits and backfilling all pits after the pipe is jacked, nor for excavation and backfill between the limits shown on the plans for jacking the pipe. Full compensation therefor will be considered as included in the price paid for jacked pipe.

Culvert pipe to be placed outside the limits for jacked

pipe shall conform to the requirements of the respective section of pipe culverts. The limits for payment of structure excavation and backfill will be the original ground line before jacking pits are excavated.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

601.05.01 Payment. The accepted quantities of culvert pipe measured as specified in subsection 601.04.01, "Measurement," will be listed under the respective sections of pipe culverts.

When any of the various sizes, types, and gages of pipe are installed by the jacking method, the contract price paid per linear foot for jacked pipe shall include full compensation for furnishing the pipe, excavating, jacking, furnishing and placing backfill material, and all incidentals and for doing all the work involved in jacking the pipe, as specified.

Full compensation for furnishing pipe with end finish, including distortion if required, will be considered as included in the price paid per linear foot for the pipe involved and no additional compensation will be allowed therefor. Full compensation for Class "B" and Class "C" bedding will be considered included in the price paid per cubic yard for backfill or granular backfill as the case may be and such payment shall include compensation for all the materials, labor, tools, and incidentals necessary to complete the work.

Class "A" bedding will be paid for at the contract unit bid price per cubic yard for Class "C" or "CA" concrete. When Class "C" or "CA" concrete is not an item on the bid schedule, Class "A" bedding will be paid for at the contract unit bid price per cubic yard for Class "A" or Class "AA" concrete. Payment as stated above shall be full compensation for all the materials, labor, tools, and incidentals necessary to complete the work.

Provisions for handling of whatever water may be encountered at the site shall be an obligation of the Contractor and payment therefor shall be considered as subsidiary

to the items involved and no further compensation will be allowed therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

SECTION 602

NON–REINFORCED CONCRETE AND CLAY PIPE

DESCRIPTION

602.01.01 General. This work shall consist of furnishing and installing new non-reinforced concrete pipe or clay culvert pipe of the kind, sizes, and dimensions shown on the plans or established by the Engineer and in accordance with the requirements of these specifications.

MATERIALS

602.02.01 General. Materials and their use shall conform to the applicable requirements of subsection 603.-02.01 of Section 603, "Reinforced Concrete Pipe" and subsection 601.02.01 of Section 601, "Pipe Culverts—General."

CONSTRUCTION

602.03.01 General. The construction requirements shall be as prescribed in subsections 603.03.01 through 603.03.06 of Section 603, "Reinforced Concrete Pipe," with the following modifications:

(a) External bands of mortar shall be placed around the pipe joints as herein specified. Several sections of pipe shall be joined before commencing banding operations, but the placing of external bands shall never be more than five (5) lengths of pipe behind joining operations.

Immediately in advance of placing external band mortar, the external surface of the pipe sections at the joint shall be thoroughly cleaned and wetted to insure proper bonding of the band mortar with the pipe. Care shall be exercised to make a union between the band and the mortar which was placed under the joint before the pipe sections were abutted. The band shall not be less than three-eighths (⅜) inch thick at the pipe joint and shall be approximately four (4) inches wide, overlapping the abutting ends of the pipe sections approximately two (2)

inches. The edges of the band shall adhere to the pipe surface to prevent peeling and shall be finished in a workmanlike manner.

(b) When irrigation or sewer pipe is placed beyond the limits of roadway excavation or embankment, the initial covering of backfill material shall be fine earth or sand approved by the Engineer. Placing the remainder of the trench backfill in layers and compacting to a relative compaction of ninety (90) percent will not be required.

(c) Openings shall be cut into irrigation or sewer pipe and connections made thereto as shown on the plans or directed by the Engineer.

Openings shall be cut to proper sizes. Connections shall be cut to fit closely and shall be strongly cemented to the pipe with banding mortar. In all cases, the area of pipe where the connection is made shall be clean and wet when the mortar is applied.

METHOD OF MEASUREMENT

602.04.01 Measurement. Method of measurement shall conform to the requirements of subsection 601.04.01, "Measurement," with the exception that backfill will not be measured for payment when placed beyond the limits of roadway excavation or embankment.

BASIS OF PAYMENT

602.05.01 Payment. Payment shall conform to the requirements of subsection 601.05.01, "Payment," and in addition thereto, the following requirements shall apply.

The accepted quantities of non-reinforced concrete or clay pipe will be paid for at the contract bid price per linear foot for the types and sizes specified.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) Non-reinforced Concrete Pipe (type)	Linear Foot
(size) Clay Pipe (type)	Linear Foot

SECTION 603

REINFORCED CONCRETE PIPE

DESCRIPTION

603.01.01 General. This work shall consist of furnishing and installing new reinforced concrete pipe, siphons, and conduits of the size, kinds, and dimensions and at locations shown on the plans or established by the Engineer and in accordance with the requirements of these specifications.

MATERIALS

603.02.01 General. Materials and their use shall conform to the applicable requirements of subsection 601.-02.01 of Section 601, "Pipe Culverts—General," and in addition thereto, the following requirements shall apply.

Flared end sections (precast) shall conform to the details and dimensions shown on the plans and except for shape, shall conform to the requirements of this section for reinforced concrete pipe.

Concrete pipe shall be carefully handled in unloading, transporting, and laying.

No pipe shall be laid which is cracked, checked, spalled, or damaged, and all such sections of pipe shall be permanently removed from the work. Pipes which show defects due to handling shall be rejected at the site of the installation regardless of prior acceptance.

Rubber gaskets shall conform to the requirements of subsection 707.03.02, "Rubber Gaskets."

Joint mortar shall be composed of one part Portland cement and two parts sand by volume.

Sand shall conform to the requirements of subsection 706.03.04, "Grout and Mortar Sand" of these specifications.

The materials shall be mixed to a consistency suitable for the purpose intended. All mortar shall be used within thirty (30) minutes after the mixing water has been added.

Admixtures of hydrated lime, fire clay, diatomaceous earth, or other approved inert material may be used in

the mortar to facilitate workability if the Contractor elects. The amount of admixture to be added shall be the quantity permitted by the Engineer.

CONSTRUCTION

603.03.01 General. Construction methods shall conform to the requirements of subsections 601.03.01 through 601.03.06 of Section 601, "Pipe Culverts—General" and in addition thereto, shall meet the following requirements.

603.03.02 Earthwork. Where pipes are to be installed in new embankment (projection), the embankment shall first be constructed to the required elevation as set forth in the following methods "A" or "B." Method "A" shall be followed unless otherwise specified in the contract documents, and with the further exception that when the pipe is to be installed on a steep slope or at a difficult location, the height of embankment to be constructed in advance of installing the pipe may be varied when permitted by the Engineer.

Method A

In the case of pipes twenty-four (24) inches or less in diameter the roadway embankment shall be constructed to an elevation of six (6) inches above the grade proposed for the top of the pipe, after which the trench shall be excavated and the pipe installed.

In the case of pipes more than twenty-four (24) inches in diameter the roadway embankment shall be constructed to an elevation of thirty (30) inches above the grade proposed for the bottom of the pipe, after which the trench shall be excavated and the pipe installed.

Method B

The new embankment shall be constructed and compacted to an elevation above the top of the pipe equal to the external diameter of the pipe plus one (1) foot and to a width each side of the pipe of not less than five times the diameter of the pipe. The trench shall then be excavated to the bottom of the pipe and to a width of the inside diameter plus three (3) feet.

After the pipe has been installed, backfill shall be placed in the trench to an elevation one (1) foot above the top of the pipe. Backfill to be placed in accordance with the requirements of Section 207, "Backfill." The lower one-third of the remaining trench shall then be filled with loose straw, hay, brush, sawdust, or other highly compressible material and the remainder of the trench shall then be filled in a normal manner. The embankment may then be constructed in the normal manner.

When pipe having bells or hubs is used, cross trenches shall be excavated for them to prevent non-uniform loading of the joints. The cross trenches shall not be more than two (2) inches wider than the width of the bell or hub.

603.03.03 Laying Culvert Pipe. The Contractor shall determine his source of supply of sand for use in mortar a sufficient time in advance of pipe laying operations to permit sampling and testing before use, and no mortar shall be used until the sand has been approved by the Engineer.

The consistency of joining mortar shall be such as to adhere to the ends of the pipe while being laid and may be easily squeezed out of the joint when the pipe sections are pressed together.

In advance of joining sections of pipe, the ends of each section shall be washed clean with a wet brush and immediately prior to placing mortar and joining the sections, the ends shall be thoroughly wetted.

Pipe sections shall be checked for alignment and grade at the time of joining the sections. If an adjustment in alignment or grade is necessary after making the joint, additional mortar shall be firmly pressed into the joint, and in the case of pipes less than twenty-four (24) inches in diameter, the internal and external surfaces of the joints shall be brushed.

The interior of the pipe shall be kept free of dirt, excess mortar, and other foreign material as the pipe laying progresses, and left clean at the completion of the work. Any pipe which is not in true alignment or which shows any undue settlement after laying, or is damaged, shall be taken up and relaid at the Contractor's expense.

The first section of pipe to be laid shall be firmly placed to the designated line and grade at the outlet end with the groove end or bell end pointing in the direction to be followed by the pipe laying.

Abutting ends of the sections of pipe to be jointed shall then be cleaned and wetted, after which joining mortar shall be firmly placed into the lower half of the groove end of the previously laid section. Joining mortar shall be firmly placed on the top half of the tongue end of the section to be jointed which shall then be inserted truly and snugly into the groove end of the section previously laid so as to completely fill the joint.

The interior joint shall then be either brushed or pointed and all surplus mortar removed from the pipe. The external space between the ends of the jointed pipe shall be firmly filled from the outside with laying mortar.

When pipe with self-centering joints and without an inside pointing recess is furnished, the inside shoulder of the groove end of each section shall first be lightly plastered or buttered with joining mortar after which the pipe ends shall be firmly fitted together in such a way that the tongue end of each section fits snugly into the groove end of the preceding section in order to center the joint and form a true flow line. The inside joints shall be troweled or brushed smooth and excess mortar removed from the pipe. The outside joint recesses shall then be filled with mortar, after which backfilling shall be performed as specified.

When pipe is furnished with self-centering joints with both inside and outside pointing recesses, the pipe shall be firmly fitted together in such a way that the tongue end of each section fits snugly into the groove end of each preceding section in order to center the joint and to form a true flow line, after which the inside joint recess shall be firmly filled with pointing mortar and then troweled or brushed smooth and excess mortar removed from the pipe, after which backfilling shall be performed as specified.

Backfill of the pipe trench may be completed while the joint mortar is still plastic. Should the joint mortar become set before the backfill is placed, backfilling of the trench

shall not be commenced within sixteen (16) hours of jointing the pipe sections. When the pipe is not backfilled while the mortar is plastic, the mortar shall be cured in accordance with subsection 501.03.09, "Curing."

Free water shall not be allowed to come in contact with the pipe line until the mortar in the joints has set at least twenty-four (24) hours.

Concrete pipe with elliptical reinforcing shall be suitably marked to clearly indicate the top and bottom of the pipe.

Prior to placing backfill material, all handling holes in concrete culverts shall be completely filled with grout.

603.03.04 Rubber Gasketed Joints. Reinforced concrete culvert pipe, connected by flexible, watertight, rubber or neoprene gasketed joints may be used in lieu of other types of joints.

All rubber gaskets shall be stored in as cool a place as practicable, preferably at seventy (70) degrees Fahrenheit or less, and in no case shall the rubber gaskets be exposed to the direct rays of the sun for more than seventy-two (72) hours.

Rubber gaskets of the type requiring lubrication, shall be lubricated with the lubricant recommended and supplied by the manufacturer of the pipe.

After the pipe has been laid, the outer and inner annular space between pipe sections shall be completely filled with cement mortar, except that no mortar shall be required if the space is three-sixteenths ($\frac{3}{16}$) inch or less in width. Where reinforced concrete collars or bells with rubber gaskets are used at the pipe joints, mortar will not be required in the outer annular space. Where pipes are used with exposed metal surfaces at the joint, both the inner and outer annular joint spaces between pipe sections must be completely filled with cement mortar, except that pipes less than twenty-four (24) inches in diameter may be pointed inside by brushing smooth and removing all surplus mortar. The rubber gasket shall be the sole element depended upon to make the joint watertight for the purposes intended.

603.03.05 Siphons and Pressure Pipe. Reinforced concrete pipe used for siphons or pressure pipe shall be laid in accordance with the above provisions, be connected by flexible, watertight rubber gasketed joint, and prior to backfilling, be subject to the following hydrostatic test:

The pipe line shall be filled with water at a hydrostatic head of ten (10) feet above the highest point of the pipeline. The pressure head shall be maintained for a period of not less than twenty-four (24) hours and any visible leak or other defects which develop under test shall be corrected by the Contractor at his expense. Sweating that does not develop into a flow or drip will not be considered as leakage. The test shall be repeated until all leaks or other defects are eliminated.

METHOD OF MEASUREMENT

603.04.01 Measurement. Method of measurement shall conform to the requirements of subsection 601.04.01, "Measurement" and in addition thereto, the following requirements shall apply.

The quantity of precast end sections, culvert pipe or oval pipe measured for payment will be the number of units of each size of each class complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

603.05.01 Payment. Payment shall conform to the requirements of subsection 601.05.01, "Payment," and in addition thereto, the following requirements shall apply.

The accepted quantities of reinforced concrete pipe measured as specified in subsection 603.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for reinforced concrete pipe of the class and size specified, which payment shall include mortar and joints. End sections will be paid for at the contract unit price bid per each for the kind and sizes specified complete and in place, which payment shall include structure excavation and backfill for precast end sections.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) Reinforced Concrete Pipe (class)	Linear Foot
(size) Oval Reinforced Conc. Pipe (class)	Linear Foot
(size) Reinforced Conc. Siphon Pipe (class)	Linear Foot
(size) Reinforced Conc. Pipe (class) Jacked	Linear Foot
(size) Precast End Section	Each
(size) Precast Oval End Section	Each

SECTION 604

CORRUGATED METAL PIPE AND METAL ARCH PIPE

DESCRIPTION

604.01.01 General. This work shall consist of furnishing and installing new corrugated metal pipe, corrugated metal arch pipes and nestable corrugated metal pipe and the relaying of old corrugated metal pipe and pipe arches at locations shown on the plans, or established by the Engineer, and in accordance with the requirements of these specifications.

MATERIALS

604.02.01 General. Materials and their use shall conform to the applicable requirements of subsection 601.-02.01 of Section 601, "Pipe Culverts—General," and in addition thereto, the following requirements shall apply.

Flared end sections (metal headwalls) shall conform to the details and dimensions shown on the plans and except for shape, shall conform to the requirements of this section for corrugated metal pipe culverts.

Culverts shall be shipped and handled in such a manner as to prevent bruising, scaling, or breaking of the spelter coating. Damaged spelter coating in lieu of the requirements of AASHO Designation M36, may be repaired by thoroughly wire brushing the damaged area and removing all loose and cracked spelter coating after which the cleaned area shall be painted with two coats of zinc oxide-zinc dust paint conforming to the requirements of Federal Specification MIL–P–15145. The paint shall be properly compounded in a suitable vehicle in the ratio of one part zinc oxide to four parts zinc dust by weight.

CONSTRUCTION

604.03.01 General. Construction methods shall conform to the requirements of subsection 601.03.01 through

601.03.06 of Section 601, "Pipe Culverts—General," and in addition thereto shall meet the following requirements.

604.03.02 Laying Culvert Pipe. All pipes shall be laid upgrade, unless otherwise permitted by the Engineer.

Corrugated metal pipe shall be so laid that flow is over the lap of the sheets. Field joints shall be made by butting the ends of pipe together and the sections joined with a band bolted firmly in place. Pipes of a diameter of forty-eight (48) inches or more shall be elongated vertically five (5) percent before placement of fill. Elongation of the vertical diameter may be accomplished by jacking in the field or by prefabrication. The method of jacking shall be subject to the approval of the Engineer. A tolerance of twenty-five (25) percent above or below the specified amount will be allowed. Where preformed elliptical pipe is used and strutting is specified, further distortion is not required but the struts shall be wedged tightly in place.

Strutting shall be carried uniformly from end to end of pipes where headwalls are not used. When headwalls are used, the amount of jacking and the length of struts may be reduced gradually under the side slopes of the embankment so that the ends of the pipe at the headwalls are circular. The struts shall be left in place until the embankment is complete and compacted, unless otherwise directed by the Engineer.

All pipes shall be laid true to the designated line, grade, and camber. They shall be fitted and matched so that when laid in the work they will form a smooth and uniform invert.

All possible care shall be used in fitting sections of pipes together so that the joint openings will not be unnecessarily large.

604.03.03 Siphons. Corrugated metal pipe for use as siphons shall be close riveted and soldered and so fabricated as to require a minimum number of field connections. All rivets on circumferential seams shall be spaced

at approximately two and one-half (2½) inch centers with a maximum spacing of three (3) inches. The circumferential and longitudinal seams on the outside of the pipe where the edges of the sheets lap, shall be soldered in workmanlike manner, solder being sweated into the joints by means of a torch properly regulated for the purpose. Soldering irons shall not be used on factory seams.

Except as provided hereinbefore, siphons shall conform to the requirements for corrugated metal pipe culverts of this section.

Field joints for close riveted and soldered corrugated metal pipe shall be approved watertight couplings consisting of a corrugated collar drawn tight by means of threaded rods and silo-type lugs. To permit the band to fit snugly into the corrugated ends of the pipe, rivets in the longitudinal seam shall be omitted and the seams adequately soldered.

Before placing the band, the ends of the pipe and the bands shall be cleaned and an amount of plastic bituminous impregnated fibre sufficient to make a rope-like section approximately three-fourths (¾) inch in diameter shall be carefully and evenly compressed into the last two valleys of the corrugation at the ends of the pipe. After placing the connecting band the entire circumference and assembly shall be hammered with a rubber or wooden mallet during the tightening of the bolts and lugs. Other approved types of water tight pipe and joints may be used.

The Contractor at his expense, prior to backfilling, shall completely fill the siphon with water and repair any leaks developing therein.

604.03.04 Relay Culvert Pipes. Corrugated metal culvert pipe, previously removed under the provisions of subsection 202.03.05, "Salvage," and designated for relaying, shall be cleaned and relayed at points called for on the plans or ordered by the Engineer.

The pipe shall be thoroughly cleaned to remove all foreign matter.

METHOD OF MEASUREMENT

604.04.01 Measurement. Method of measurement shall conform to the requirements of subsection 601.04.01, "Measurement" and in addition thereto, the following requirements shall apply:

The quantity of corrugated metal end sections for culvert pipe or pipe arch measured for payment will be the number of units of each size of each class complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

604.05.01 Payment. Payment shall conform to the requirements of subsection 601.05.01, "Payment," and in addition thereto, the following requirements shall apply.

The accepted quantities of corrugated metal pipe, measured as specified in subsection 604.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for the types and sizes specified. End sections will be paid for at the contract unit price bid per each for the kind and size specified, which payment shall include structure excavation and backfill for fabricated end sections.

When culvert pipe is designated to be relayed, hauling of the pipe, from the site of removal or from the place where stored to the point or points at which they are to be reinstalled, shall be considered subsidiary to the pipe item and no further compensation will be allowed therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) Corrugated Metal Pipe (type)	Linear Foot
(size) Corrugated Metal Pipe (type) Jacked	Linear Foot
(size) Relay Culvert Pipe (type)	Linear Foot
(size) Corr. Metal Arch Pipe (type)	Linear Foot
(size) Corr. Metal Siphon Pipe (type)	Linear Foot
(size) Corr. Metal Nestable Pipe (type)	Linear Foot
(size) Corr. Metal End Section (type)	Each
(size) Corr. Metal Arch End Section (type)	Each

SECTION 605

ALUMINUM CORRUGATED METAL PIPE AND ALUMINUM ARCH CULVERTS

DESCRIPTION

605.01.01 General. This work shall consist of furnishing and installing new corrugated aluminum culvert pipe and pipe arches at the location shown on the plans, or established by the Engineer, and in accordance with the requirements of these specifications.

MATERIALS

605.02.01 General. Materials and their use shall conform to the applicable requirements of subsection 601.-02.01 of Section 601, "Pipe Culverts—General."

CONSTRUCTION

605.03.01 General. The construction requirements shall be as prescribed in subsections 604.03.01 through 604.03.06 of Section 604, "Corrugated Metal Pipe and Metal Arch Pipe."

METHOD OF MEASUREMENT

605.04.01 Measurement. Method of measurement shall conform to the requirements of subsection 601.04.01, "Measurement."

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

605.05.01 Payment. Payment shall conform to the requirements of subsection 601.05.01, "Payment," and in addition thereto, the following requirements shall apply.

The accepted quantities of corrugated aluminum pipe and aluminum arch pipe will be paid for at the contract price per bid linear foot for the types and sizes specified.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) Corrugated Aluminum Pipe	Linear Foot
(size) Corrugated Aluminum Arch Pipe	Linear Foot

SECTION 606

STRUCTURAL PLATE PIPE AND PIPE ARCH CULVERTS

DESCRIPTION

606.01.01 General. This work shall consist of furnishing and installing new structural plate pipe and pipe arch culverts conforming to the requirements of these specifications, and of the sizes and dimensions required in the plans, and installing such structures at locations designated in the plans or established by the Engineer, and in conformity with the lines and grades established by the Engineer. The work shall also include the reinstallation of salvaged structural plate pipe and pipe arch culverts.

Plates for a pipe arch shall form a cross section made up of four circular arcs tangent to each other at their junctions and symmetrical about the vertical axis. The top shall be an arc of not more than one hundred eighty (180) degrees nor less than one hundred fifty-five (155) degrees. The bottom shall be an arc of not more than fifty (50) degrees nor less than ten (10) degrees. The top shall be joined at each end to the bottom by an arc having a radius between sixteen (16) and twenty-one (21) inches and of not more than eighty-seven and one-half (87½) degrees nor less than seventy-five (75) degrees.

MATERIALS

606.02.01 General. Materials shall meet the requirements specified in subsection 709.03.08, "Structural Plate Pipe and Pipe Arches."

If called for in the bid schedule, plates for pipes and pipe arches shall be bituminous coated in accordance with AASHO Designation: M190, Type A, B or C.

The bottom plates of structural plate pipes and arches shall be one gage heavier than the gage specified in the bid schedule, which will apply to top and side plates. When gage one (1) is specified, the bottom plates shall also be gage one (1).

Plates shall be shipped and handled in such a manner as

to prevent bruising, scaling, or breaking of the spelter coating. Damaged spelter coating in lieu of the requirements of AASHO Designation M36, may be repaired by thoroughly wire brushing the damaged area and removing all loose and cracked spelter coating after which the cleaned area shall be painted with two coats of zinc oxide-zinc dust paint conforming to the requirements of Federal Specification MIL–P–15145. The paint shall be properly compounded in a suitable vehicle in the ratio of one part zinc oxide to four parts zinc dust by weight.

Planned lengths and sizes are approximate. The Contractor shall not order and deliver the plates until a list of sizes and lengths is furnished him by the Engineer.

CONSTRUCTION

606.03.01 Description Plates. Plates shall consist of structural units of galvanized corrugated metal. Single plates shall be furnished in standard sizes to permit structure length increments of two (2) feet. (Plates have approximately a two (2) inch lip beyond each end crest, which results in the actual length of a given structure being approximately four (4) inches longer than the nominal length, except when skewed or beveled.)

The plates at longitudinal and circumferential seams shall be connected by bolts. Joints shall be staggered so that not more than three plates come together at any one point. Each plate shall be curved to one or more circular arcs.

606.03.02 Fabrication. Plates shall be formed to provide lap joints. The bolt holes shall be so punched that all plates having like dimensions, curvature, and the same number of bolts per foot of seam shall be interchangeable. Each plate shall be curved to the proper radius so that the cross sectional dimensions of the finished structure will be as specified.

Unless otherwise specified, bolt holes along those edges of the plates that will form longitudinal seams in the finished structure shall be staggered in rows two (2) inches apart, with one row in the valley and one in the crest of the corrugations. Bolt holes along those edges of the plates

that will form circumferential seams in the finished structure shall provide for a bolt spacing of not more than twelve (12) inches. The minimum distance from center of hole to edge of the plate shall be not less than one and three-fourths times the diameter of the bolt. The diameter of the bolt holes in the longitudinal seams shall not exceed the diameter of the bolt by more than one-eighth (⅛) inch.

Burnt edges shall be free from oxide and burrs and shall present a workmanlike finish. Damaged spelter on the surface of the plates and the edges of cuts shall be repaired as set forth in subsection 606.02.01, "General," within twenty-four (24) hours after the cuts are made. Each cut plate shall be legibly identified to designate its proper position in the finished structure.

606.03.03 Field Inspection. The Engineer shall be furnished with an itemized statement of the number and length of the plates in each shipment by the manufacturer. Each plate included in a shipment shall conform to the requirements of these specifications. If twenty-five (25) percent or more of the plates in any shipment fail to conform to the requirements, the entire shipment may be rejected.

606.03.04 Earthwork. Excavation and backfill shall conform to the requirements of Sections 206, "Structure Excavation" and 207, "Backfill."

The pipe shall be laid in a trench excavated to the lines and grades established by the Engineer. The bottom of the trench shall be graded and prepared to provide full contact with the pipe throughout its entire length.

Where pipes are to be installed in new embankments on a steep slope or in a difficult location, the height of new embankments may be varied when permitted by the Engineer before installing pipes.

When headwalls are not required and granular materials are used for backfilling, the fill at the ends of the structure shall be sealed against the infiltration of water by bedding the ends of the structure in well tamped clay as shown on the plans.

When the pipe is laid in rock, hard clay, shale, or other

hard material, a space below the pipe shall be excavated and replaced with a bed of compacted sand or compacted earth fill. In no place shall the pipe be laid directly on the rock, hard clay, shale, or other hard material.

When sand or compacted fill is used, the depth of the sand or compacted fill below the pipe shall not be less than one-third the inside diameter of the pipe with a minimum of four (4) inches and a maximum of twelve (12) inches with the exception that an extra one-half (½) inch shall be added for every foot the trench exceeds sixteen (16) feet in depth. This bed shall extend at the sides of the pipe at least a distance of one-fourth (¼) the outside diameter of the pipe.

606.03.05 Assembling. The structural plate structures shall be assembled in accordance with the manufacturer's assembly instructions. The unsupported edges of all plates shall be held in position by temporary props. Each row of side plates shall extend far enough to support the plate above until the first complete ring has been assembled. A sufficient number of bolts shall be progressively installed to hold the plates in position. Bolts shall not be tightened until tightening will not interfere with the adjustment and matching of additional plates and sections. Special care shall be exercised in the use of drift pins or pry bars to prevent chipping or injury to the galvanized or other protective coating, and such injury shall be repaired as set forth in subsection 606.02.01, "General," at the Contractor's expense. After all plates are in place, the bolts shall be progressively and uniformly tightened from one end of the structure, and the tightening operation repeated to be sure that all bolts are tight. Bolts shall be tightened to a minimum of (a) one hundred (100) foot-pounds of torque for plates of 7 gage and lighter, and (b) one hundred fifty (150) foot-pounds of torque for plates of 5 gage and heavier, and shall be rechecked and retightened as necessary just prior to backfilling.

The elliptical-shaped pipes shall be installed with their long diameter vertical, and pipe arches shall be installed with their span width horizontal.

606.03.06 Strutting. When specified, structural plate pipes which are not fabricated out of round before erection, shall be timber strutted vertically three (3) percent out of round before placement of the embankment.

The pipe shall be deformed to the required degree by means of suitable jacks. The method of jacking shall meet with the approval of the Engineer. A tolerance of twenty-five (25) percent above or below the specified elongation will be permitted.

Strutting shall be carried uniformly from end to end of the pipe. The struts shall be left in place until the embankment is complete and compacted, unless otherwise ordered by the Engineer.

In lieu of strutting structural plate pipe, the Contractor may furnish structural plate pipe with the vertical axis fabricated out of round five (5) percent of the nominal diameter from end to end of the pipe. A tolerance of twenty-five (25) percent above or below the specified elongation will be permitted. The elongation shall be made by approved shop methods, and any coating damaged or destroyed shall be repaired or replaced satisfactorily.

606.03.07 Workmanship. It is the essence of these specifications that, in addition to compliance with the details of construction, the completed pipe shall show careful, finished workmanship in all particulars. Structural plates on which the spelter coating has been bruised or broken or which shows defective workmanship, shall be rejected, except as herein otherwise specified. The requirement applies not only to the individual plates, but to the shipment on any contract as a whole. Among others, the following defects are specified as constituting poor workmanship and the presence of any or all of them in any individual culvert plate, or in general in any shipment, shall constitute sufficient cause for rejection:

(a) Uneven laps.
(b) Variation from a straight center line.
(c) Ragged edges.
(d) Loose, unevenly lined or spaced bolts.

(e) Bruised, scaled or broken spelter coating. (See subsection 606.02.01 for exception.)

(f) Dents or bends in the metal itself.

606.03.08 Headwalls. Where shown on the plans, inlet and outlet headwalls shall be constructed or installed in connection with structural plate pipe. Where such headwalls are constructed or installed, the ends of pipes shall be placed flush or cut off flush with the headwall face, unless otherwise permitted by the Engineer. Headwalls to be constructed to conform to the applicable requirements of Sections 501, "Portland Cement Concrete" and 502, "Concrete Structures."

606.03.09 Extending Existing Structural Plate Pipe and Pipe Arch Culverts. In case the plans provide for the extension of any old or existing structural plate pipe or pipe arch culverts, the connection of the old and new sections shall be made by punching any necessary bolt holes, furnishing bolts, nuts and washers, changing location of individual plates on pipe arches, and any other work required in the completion of the connection in a workmanlike manner. In all cases where an existing headwall is in place, the concrete shall be completely removed in accordance with the provisions of Section 202, "Removal of Structures and Obstructions."

METHOD OF MEASUREMENT

606.04.01 Measurement. The materials to be paid for under these specifications will be listed in the contract items by the various sizes, types, and gages necessary for identification.

The quantity of structural plate pipe or pipe arches measured for payment will be the number of linear feet complete and in place. The number of linear feet shall be the average of the top and bottom centerline lengths for structural plate pipe and pipe arches.

Structure excavation and structure backfill, Portland cement concrete and reinforcement required for headwalls, structures, and other items required to complete the

work will be measured and paid for under their respective sections of these specifications.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

606.05.01 Payment. The accepted quantities of structural plate pipe and pipe arches measured as specified in subsection 606.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for the types and sizes specified.

Full compensation for furnishing structural plate pipe and pipe arches with end finish, including distortion, if required, will be considered as included in the price paid per linear foot for the plates and pipe involved and no additional compensation will be allowed therefor.

Provisions for handling of whatever water may be encountered at the site shall be an obligation of the Contractor, and payment therefor shall be considered as subsidiary to the items involved and no further compensation will be allowed therefor.

It is understood that the gage of metal in the bottom plates of pipes and pipe arches is to be of a gage heavier than that specified in the bid schedule as set forth in subsection 606.02.01, "General," unless otherwise specified. No separate or additional compensation will be made by reason of supplying the heavier gage but compensation therefor shall be considered an integral part of the contract price paid for the gage specified.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) Structural Plate Pipe (type) (gage)	Linear Foot
(size) Structural Plate Pipe Arch (type) (gage)	Linear Foot

SECTION 607

UNDERDRAINS

DESCRIPTION

607.01.01 General. This work shall consist of constructing underdrains using pipe and drain backfill in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established by the Engineer.

MATERIALS

607.02.01 General. Materials shall meet the requirements specified in the following subsections:

Corrugated Metal Pipe for Underdrains	Subsection 709.03.05
Bituminous Coated Corrugated Metal Pipe for Underdrains	Subsection 709.03.06
Perforated Concrete Pipe	Subsection 708.03.03
Clay Pipe	Subsection 708.03.04
Corrugated Aluminum Pipe for Underdrains	Subsection 709.03.07
Drain Backfill	Subsection 704.03.01

When the location of manufacturing plants allows, the plants will be inspected periodically for compliance with specified manufacturing methods, and materials samples will be obtained for laboratory testing for compliance with materials quality requirements. This can be the basis for acceptance of manufacturing lots as to quality.

All materials will be subject to inspection for acceptance as to condition at the latest practicable time the Engineer has the opportunity to check for compliance prior to or during incorporation of materials into the work.

The Contractor shall not order and deliver the pipe until a correct list of sizes and lengths is furnished him by the Engineer.

Pipe shall be shipped and handled in such a manner as to prevent bruising, sealing, or breaking. Corrugated metal pipe with damaged spelter coating may be repaired in accordance with subsection 604.02.01 of Section 604, "Corrugated Metal Pipe." Concrete or clay pipe which is cracked, checked, spalled, or damaged shall not be laid.

Pipes which show defects due to handling shall be rejected at the site of the installation regardless of prior acceptance.

CONSTRUCTION

607.03.01 Earthwork. Excavation and drain backfill shall conform to the requirements of Sections 206, "Structure Excavation," and 209, "Drain Backfill," with the following modifications:

(a) Trenches shall be excavated to the dimensions and grade required by the plans or as directed. A minimum six (6) inch bedding layer of drain backfill material shall be placed in the bottom of the trench for its full width and length.

(b) The space below the pipe shall be filled with the required drain backfill throughout its entire length, and brought to a uniform grade. All material excavated from trenches, not required for backfilling, nor usable in the roadway, shall be removed and disposed of by the Contractor.

(c) If an item for grouting drain backfill is shown in the proposal, drain backfill shall be covered with a thick grout not less than one (1) inch in thickness. The grout shall be composed of one part Portland cement and five parts sand. This grout shall be thoroughly tamped to provide an impervious layer over the entire surface of the drain backfill.

607.03.02 Laying Pipes. Bell and spigot tile shall be laid upgrade with the bell end upgrade and the spigot end not quite fully entered in the adjacent bell. Pipe shall be laid true to line and grade with a uniform bearing under the full length of the barrel. The pipe joints shall then be covered with two-ply tar paper strips not less than six (6) inches in width and of sufficient length to permit the ends being turned outward and laid flat on the bottom course of drain backfill on either side of the pipe for a distance of three (3) inches.

Perforated pipe shall be laid with the perforations at the bottom of the pipe and the sections joined with band

couplers. The pipe shall be firmly bedded throughout its length.

607.03.03 Underdrain Outlets. Trenches for underdrain outlets shall be excavated to the width and depth shown on the plans. Pipe shall be laid in the trench with all ends firmly joined by the applicable methods and means. After inspection and approval of the pipe installation, the trench shall be backfilled with structure backfill material in layers and compacted as provided in Section 209, "Drain Backfill."

METHOD OF MEASUREMENT

607.04.01 Measurement. The materials to be measured for payment under these specifications will be listed in the contract items by size, class, type gage, or whatever information is necessary for identification.

The quantity of underdrain pipe measured for payment will be the actual number of linear feet of pipe complete and in place. Underdrain pipe bends, wyes, tees, and other branches will be measured along center lines to the point of intersection.

The quantity of grouted drain backfill measured for payment will be the number of linear feet of drain grouted, measured along the longitudinal axis of the drain, in the completed work.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

607.05.01 Payment. The accepted quantities of underdrain pipe measured as specified in subsection 607.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for the types and sizes specified.

The accepted quantity of grouted drain backfill measured as provided in subsection 607.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for Grouting Drain Backfill.

Structure excavation and drain backfill will be measured and paid for as separate items as provided in Sections 206, "Structure Excavation" and 209, "Drain Backfill."

Provisions for handling of whatever water may be encountered, at the site, shall be an obligation of the Contractor and payment therefor shall be considered as subsidiary to the items involved and no further compensation will be allowed therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) Perforated Corrugated Metal Pipe for Underdrains (type)	Linear Foot
(size) Nonperforated Corrugated Metal Pipe for Underdrains (type)	Linear Foot
(size) Perforated Concrete Pipe for Underdrains (type)	Linear Foot
(size) Clay Pipe for Underdrains (type)	Linear Foot
(size) Corrugated Aluminum Pipe for Underdrains (type)	Linear Foot
Grouting Drain Backfill (width)	Linear Foot

SECTION 608

DOWNDRAINS

DESCRIPTION

608.01.01 General. This work shall consist of furnishing and installing embankment protectors, flume downdrains, anchor assemblies, slip joints, and bituminous concrete downdrains to collect and carry surface drainage down the roadway slopes.

MATERIALS

608.02.01 General. The materials used shall be those prescribed or used for the several items which constitute the finished work and shall conform to the requirements in the following subsections:

Corrugated Metal Pipe for Downdrains	Subsection 709.03.04
Corrugated Aluminum Pipe	Subsection 709.03.03
Surfacing Miscellaneous Areas	Subsection 401.03.14
Grouted Riprap	Subsection 610.03.04

Downdrain metal products shall be fabricated in accordance with the details and dimensions shown on the plans, except that minor variations may be accepted at the discretion of the Engineer to permit the use of manufacturer's standard jigs and templets in the fabrication. Metal shall not be less than the gage shown on the plans.

Each separate downdrain installation shall be assembled from one material only. Ferrous metal and aluminum shall not be used in the same installation, except that the anchor assemblies as shown on the plans may be used with an aluminum installation provided the anchor assemblies are electrically insulated.

Corrugated metal parts with damaged spelter coating shall be repaired in accordance with subsection 604.02.01 of Section 604, "Corrugated Metal Pipe."

CONSTRUCTION

608.03.01 Metal Downdrains. The embankment protector outlet pipe shall be connected to a downdrain pipe

of the dimensions shown on the plans by means of a band coupler or a slip joint.

Embankment protectors shall be installed at the outside edge of the embankment gutters or in shoulder dikes to carry drainage from the roadbed down the embankment slopes to protect the slopes and shoulders from erosion. The entrance device shall be so installed as to prevent water from percolating around the structure and care shall be taken to prevent the structure from being undermined. The seal between the structure and the surrounding earth shall be made watertight. The embankment protectors shall be placed in such a manner that the lower edge of the opening will be from three (3) inches to six (6) inches below the bottom of the gutter flow lines.

608.03.02 Bituminous Mixtures and Grouted Riprap. Bituminous mixture and grouted riprap downdrains when called for, shall be placed in accordance with the provisions in subsection 401.03.14, "Surfacing Miscellaneous Areas," or subsection 610.03.04, "Grouted Riprap."

METHOD OF MEASUREMENT

608.04.01 Measurement. The materials to be measured for payment under these specifications will be listed in the contract items by size, type, etc., or whatever information is necessary for identification.

The quantity of embankment protectors, slip joints, and anchor assemblies will be measured as units complete and in place.

Type 1 and 3 embankment protectors shall include the length of the tapered section and the length of tail pipe shown on the plans and this length of tail pipe will not be measured as downdrain pipe.

Type 2 embankment protectors shall include the length of tapered section and a five (5) inch flume stub and said stub will not be measured as flume downdrain.

An anchor assembly shall consist of pipe stakes, rods, and hardware for fastening downdrain pipe or flume downdrain as shown on the plans. For payment purposes, a flume downdrain anchor assembly shall include two pipe stakes with necessary clip brackets and bolts.

The quantity of corrugated metal pipe downdrains measured for payment will be the number of linear feet complete and in place, exclusive of the length of tail pipe attached to the entrance taper as provided above for entrance tapers. Pipe placed in excess of the length designated will not be measured for payment unless pipes are cut to fit a structure or slope. When pipes are cut to fit a structure or slope, the quantity to be paid for will be the length of pipe necessary to be placed before cutting, measured in even two (2) foot increments.

The quantity of elbows, wyes, tees, and other branches measured for payment will be the number of linear feet for the size and type of pipe involved, complete and in place. Wyes, elbows, tees, and other branches will be measured along centerlines to the point of intersection.

The quantity of corrugated metal flume downdrain measured for payment will be the number of linear feet complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

608.05.01 Payment. The accepted quantities of embankment protectors, slip joints and anchor assemblies measured as specified in subsection 608.04.01, "Measurement," will be paid for at the contract unit price bid per each for the types and sizes specified.

The accepted quantities of downdrain pipe or downdrain flume, measured as specified in subsection 608.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for downdrain pipe or flume for the types and sizes specified.

Payment for structure excavation and structure backfill will be considered subsidiary to the items of embankment protectors and downdrain pipe or flume and no further compensation will be allowed therefor.

Plantmix bituminous mixture used in downdrains will be paid for as provided in Section 401, "Plantmix Bituminous Pavements." The cost incurred for preparing the ditch and all incidentals not specifically mentioned herein

will be paid for on a square yard basis as provided in Section 402, "Plantmix Bituminous Surface." Drainage excavation will not be paid for on plantmix bituminous downdrains.

Quantities of grouted riprap placed for downdrains will be paid for according to the provisions of Section 610, "Riprap."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Embankment Protector (type)	Each
Slip Joints	Each
Anchor Assembly	Each
(size) Downdrain Pipe (type)	Linear Foot
Downdrain Flume	Linear Foot

SECTION 609

CATCH BASINS, MANHOLES, AND INLETS

DESCRIPTION

609.01.01 General. This work shall consist of constructing or reconstructing catch basins, manholes, inlets, and similar structures, consisting of Portland cement concrete with necessary reinforcement, metal frames, grates, and lids, including required excavation and backfilling.

MATERIALS

609.02.01 General. Materials shall conform to the requirements specified in the following sections:

Portland Cement Concrete	Section 501
Reinforcing Steel	Section 505
Miscellaneous Metals	Section 712
Gray Iron Castings	Subsection 712.03.02

Portland cement concrete shall be Class A or Class AA unless otherwise provided.

Casting shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting strength and value for the service intended. Casting shall be boldly filletted at angles and the arrises shall be sharp and perfect. Casting shall be sand blasted or otherwise effectively cleaned of scale and sand so as to present a smooth, clean, and uniform surface.

Mortar for setting grates shall be mixed in the proportions of one part cement to three parts of fine aggregate.

CONSTRUCTION

609.03.01 General. Catch basins, inlets, and manholes shall be constructed in accordance with all of the requirements of Section 501, "Portland Cement Concrete." Inlet and outlet pipes shall be placed prior to pouring concrete.

Grates shall be set in full mortar beds or otherwise

secured as shown on the plans. Grates shall be set accurately to the final elevations so that no subsequent adjustments will be necessary. Concrete covers, when indicated on the plans, shall be constructed in such manner that they will fit snugly and be readily removable. Structural steel grates shall be painted as specified in Section 614, "Painting."

Pipe or tile placed in masonry for inlet or outlet connections shall extend through the walls and beyond the outside surfaces of the walls a sufficient distance to allow for connections with conduits and the masonry shall be carefully constructed around them so as to prevent leakage around their outer surfaces.

609.03.02 Adjusting Catch Basin, Manhole, and Inlet Covers. Unless otherwise provided on the plans or by the contract, existing covers, including frames, grates, or lids shall be adjusted to the required elevation by removing such existing covers and adjusting the top of the existing structures by removing or adding concrete, brick masonry or concrete block masonry, as the case may be, reinstalling the fixtures by supporting them on a satisfactory collar of concrete masonry, Class A or AA so constructed as to hold them firmly in place.

609.03.03 Clean Out. All catch basins, manholes, inlets, and similar structures shall be thoroughly cleaned of any accumulations of silt, debris, or foreign matter of any kind, and shall be clean of such accumulations at the time of final inspection.

609.03.04 Earthwork. Structure excavation and structure backfill shall conform to the requirements of Sections 206, "Structure Excavation" and 207, "Backfill."

METHOD OF MEASUREMENT

609.04.01 Measurement. The quantities of castings and structural steel grates measured for payment will be the number of pounds, complete and in place. The weight of castings shall be computed from the dimensions shown on the approved shop drawings, assuming the cast iron to

weigh four hundred fifty (450) pounds per cubic foot, with an allowance of ten (10) percent for fillets and overrun. The weight of structural steel grates shall be computed from the dimensions shown on the approved shop drawings, in accordance with Section 506, "Steel Structures." Certified shop weights will be acceptable in lieu of computed weights.

Adjusting covers for catch basins, manholes, and inlets will be measured per each complete and in place.

Precast manholes of the type and dimensions shown on the plans will be measured per each complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

609.05.01 Payment. The accepted quantities of grates measured as provided in subsection 609.04.01, "Measurement," will be paid for at the contract unit price bid per pound for types and sizes specified.

The work for adjusting covers measured as specified in subsection 609.04.01, "Measurement," will be paid for at the contract unit price bid per each for adjusting covers for catch basins, manholes, and inlets, which price shall be full compensation for furnishing all materials, tools, incidentals, and labor required to adjust the covers.

Portland cement concrete used in new structures of catch basins and inlets will be paid for as specified in Section 502, "Concrete Structures."

Reinforcing steel in catch basins and inlets will be paid for as specified in Section 505, "Reinforcing Steel."

The accepted quantity of precast manholes measured as provided in subsection 609.04.01, "Measurement" will be paid for at the contract unit price bid per each for types and sizes specified. This price shall be full compensation for furnishing all materials including structure excavation and structure backfill, Portland cement concrete, steel, castings, and incidentals necessary to complete the work.

Structure excavation and structure backfill for catch basins and inlets will be paid for as specified in Sections 206, "Structure Excavation" and 207, "Backfill."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Castings	Pound
Structural Steel Grates	Pound
(size) Precast Reinforced Concrete Manhole (type)	Each
Adjusting Covers	Each

SECTION 610

RIPRAP

DESCRIPTION

610.01.01 General. This work shall consist of furnishing and placing riprap (with or without grout), heavy riprap or sacked Portland cement concrete riprap, as the case may be, in accordance with the requirements of the plans and these specifications.

MATERIALS

610.02.01 General. All materials shall conform to the requirements specified in the following sections:

Water	Section 722
Stone for Masonry and Riprap	Subsection 706.03.05
Portland Cement	Section 701
Grout and Mortar Sand	Subsection 706.03.04

When so provided, waste concrete slaps may be substituted for the above-designated stone. In such case, the concrete shall be sound and the slaps shall meet the size requirements as specified for stone.

Grout shall be composed of one part by volume of Portland cement and three parts by volume of sand and shall be of such consistency that it will fill voids in the riprap.

The mixed concrete shall contain three hundred seventy-six (376) pounds (four sacks) of Portland cement per cubic yard.

The amount of water added at the time of mixing shall be such as will produce a mixture with a slump of from three (3) inches to five (5) inches when tested in accordance with the method described in Section 501 of these specifications.

Unless otherwise provided in the special provisions, aggregate for use in sacked concrete riprap shall consist of river run material of a sandy, gravelly nature, clean and free from roots, vegetable matter, and other deleterious substances. When tested on laboratory sieves, river run

material shall conform to the following grading requirements:

Passing a 2-inch sieve	80 to 100 percent
Passing a No. 200 sieve	0 to 4 percent

The nominal sizes of the various stones used will be as follows:

(a) Size of Riprap. Individual stones shall have a thickness of not less than eight (8) inches and a width of not less than one and one-half (1½) times the thickness. No stones except headers shall have a length less than one and one-half (1½) times their width. The stones shall decrease in thickness from the bottom to the top of the wall.

(b) Size of Heavy Riprap. Size of riprap stone shall be as large as can be conveniently placed in layer thickness specified. In layers two (2) feet or less in thickness, the stones, excepting spalls used to chink interstices, shall weigh not less than fifty (50) pounds, and at least sixty (60) percent of them shall weigh more than one hundred (100) pounds each. In layers more than two (2) feet in thickness at least fifty (50) percent of the mass shall be stones having a volume of two (2) cubic feet or more.

CONSTRUCTION

610.03.01 Earthwork. The bed for the riprap shall be properly trimmed and shaped. Excavations for trenches, footings, cutoff walls, etc., shall conform to the requirements of Section 206, "Structure Excavation." Gradation and compaction requirements on structure backfill will not apply.

610.03.02 Riprap. Stone placed below the water line shall be distributed so that the minimum thickness of the riprap is not less than that specified.

Stone placed above the water line shall be placed by hand. It shall be laid with close, broken joints and shall be firmly bedded into the slope and against the adjoining stones. The stones shall be laid perpendicular to the slope with the ends in contact. The riprap shall be thoroughly compacted as construction progresses and the finished surface shall present an even, tight surface. The larger stone

shall be placed in the lower courses. Interstices between stones shall be chinked with spalls firmly rammed into place.

610.03.03 Heavy Riprap. Heavy riprap may be placed by any mechanical means that will produce a complete job within reasonable tolerances of the typical section shown on the plans. Hand work will be limited to the amount necessary to fill large voids or to correct segregated areas.

610.03.04 Grouted Riprap. When grouted riprap is specified, the stone shall be laid as set forth above for riprap placed above the water line. The spaces between the stones shall then be filled with grout. Sufficient grout shall be used to completely fill all voids, except that the face surface of the stone shall be left exposed. After grouting is completed, the surface shall be cured as specified in Section 502, "Concrete Structures" for a period of at least three (3) days.

610.03.05 Sacked Concrete Riprap. Sacks for concrete riprap shall be made of at least ten (10) ounce burlap and shall be approximately nineteen and one-half (19½) inches by thirty-six (36) inches measured inside the seams when the sack is laid flat. The capacity of each sack shall be approximately one and twenty-five hundredths (1.25) cubic feet. Sound reclaimed sacks may be used. The sacks shall be filled with concrete, loosely placed so as to leave room for folding at the top, the fold to be just enough to retain the concrete at the time of placing. Not more than one (1) cubic foot of concrete shall be placed in each sack. Immediately after being filled with concrete, the sacks shall be placed and lightly trampled to cause them to conform with the earth face and with adjacent sacks in place.

The slopes on which the sacked concrete riprap is to be placed shall be finished true to line and grade. The first course shall consist of a double row of stretchers laid in a neatly trimmed trench, and the second course shall consist of a single row of headers. The third and remaining course

shall consist of stretchers and shall be placed in such a manner that joints in succeeding courses are staggered. All dirt and debris shall be removed from the top of the sacks before the next course is laid thereon. Stretchers shall be placed so that the folded ends will not be adjacent. Headers shall be placed with the folds toward the earth face. Not more than four vertical courses of sacks shall be placed in any tier until initial set has taken place in the first course of any such tier.

When, in the opinion of the Engineer, there will not be proper bearing or bond for the concrete due to delays in placing succeeding layers of sacks or due to the work having been hampered by storms or mud or for any cause, a small trench shall be excavated back of the row of sacks already in place, which trench shall be filled with fresh concrete before the next layer of sacks is laid.

Sacked concrete riprap shall be cured by covering with a blanket of wet earth or by sprinkling with a fine spray of water every two (2) hours during the daytime for a period of four (4) days.

METHOD OF MEASUREMENT

610.04.01 Measurement. The quantity of riprap, heavy riprap, and grouted riprap measured for payment will be the number of cubic yards complete and in place.

The quantity of sacked concrete riprap to be measured for payment will be the number of cubic yards at the mixer. Only work placed within the dimensions shown on the plans or ordered by the Engineer, will be measured for payment.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

610.05.01 Payment. The accepted quantities of riprap, heavy riprap, grouted riprap, and sacked concrete riprap measured as provided in subsection 610.04.01, "Measurement" will be paid for at the contract unit price bid per cubic yard for the type specified.

Structure excavation for trenches, footings, cutoff walls, etc., will be paid for in accordance with Section 206, "Structure Excavation." Backfill will be considered as included in the price paid for structure excavation and no separate payment will be made therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Riprap	Cubic Yard
Heavy Riprap	Cubic Yard
Grouted Riprap	Cubic Yard
Sacked Riprap	Cubic Yard

SECTION 611

CONCRETE SLOPE PAVING

DESCRIPTION

611.01.01 General. This work shall consist of constructing concrete slope paving and aprons, and concrete cutoff walls in connection therewith, to the lines and grades established by the Engineer and in accordance with the design shown on the plans.

MATERIALS

611.02.01 General. Materials shall conform to the requirements specified in the following sections:

Portland Cement Concrete	Section 501
Reinforcing Steel	Section 505

Concrete slope paving and aprons and concrete cutoff walls shall be Class A or Class AA Portland cement concrete.

CONSTRUCTION

611.03.01 Earthwork. The subgrade shall be constructed true to line and grade, as shown on the plans or established by the Engineer. It shall be thoroughly watered and rolled or tamped until hard and solid before placing the concrete. All soft or spongy material shall be removed to a minimum depth of six (6) inches below subgrade elevation, the resulting space filled with selected material, sand or gravel, and thoroughly watered and rolled or tamped until a firm foundation is secured.

Excavations for trenches, footings, cutoff walls, etc., shall conform to the requirements of Section 206, "Structure Excavation." Gradation and compaction requirements on structure backfill will not apply.

611.03.02 General. Concrete, after spreading, shall be tamped until it is thoroughly compact and mortar flushes to the surface. If the slope is too steep to permit the use of concrete sufficiently wet to flush with tamping,

the concrete may be tamped until consolidated and a mortar surface one-fourth (¼) inch thick troweled on immediately. The mortar shall consist of one part Portland cement and three parts of clean, sharp sand. The mortar surface shall be considered as a part of the concrete and no additional allowance will be made therefor.

After striking off to grade, the concrete shall be hand floated with wooden floats not less than four (4) inches in width and not less than thirty (30) inches in length. Care shall be taken to prevent rotary marks of the hand floats. The entire surface shall be broomed with a fine texture hair push broom to produce a uniform surface and eliminate float marks. Brooming shall be done when the surface is sufficiently set to prevent deep scarring and shall be accomplished by drawing the broom down the slope leaving the marks parallel to the edges of the panel. Joints shall be edged with a one-fourth (¼) inch radius edger prior to the brooming.

Expansion joints shall be filled with a durable resilient expansion joint filler one-half (½) inch thick conforming to the requirements of Section 707, "Joint Materials."

Concrete slope paving, aprons and cutoff walls shall be cured as specified in Section 502, "Concrete Structures."

METHOD OF MEASUREMENT

611.04.01 Measurement. The quantity of concrete slope paving and concrete aprons measured for payment will be the number of cubic yards complete and in place.

The quantity will be computed from measurements of the actual areas placed based on the theoretical thickness shown on the plans. No additional allowance will be made for additional concrete placed by reason of low subgrades.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

611.05.01 Payment. The accepted quantities of concrete slope paving and concrete aprons measured as provided in subsection 611.04.01, "Measurement," will be

paid for at the contract unit price bid per cubic yard for the class specified.

Structure excavation for trenches, footings, cutoff walls, etc., will be paid for in accordance with Section 206, "Structure Excavation." Structure backfill will be considered subsidiary to other pay items of the work and no further compensation will be allowed for backfill. Reinforcement shall be paid for in accordance with Section 505, "Reinforcing Steel."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(class) Concrete Slope Pavement	Cubic Yard
(class) Concrete Aprons	Cubic Yard

SECTION 612

METAL BIN-TYPE RETAINING WALLS

DESCRIPTION

612.01.01 General. This work shall consist of furnishing and installing metal retaining walls of the bin type at the locations shown on the plans or designated by the Engineer and in reasonably close conformity to the lines, grades, basic designs, and dimensions shown on the plans or established by the Engineer.

The bin-type wall comprises prefabricated members with fittings and appurtenances for complete assembly in the field. The basic design of the wall refers to the length of wall spacers affecting depth of wall.

MATERIALS

612.02.01 General. The galvanized sheets used in fabricating the several members shall conform to the applicable requirements of AASHO M36 (Corrugated Metal Culvert Pipe). Bolts, nuts, and miscellaneous hardware shall be galvanized.

The various members shall be fabricated from specified metal of the respective gages shown on the plans, but not lighter than 16 gage. In the absence of given gages or dimensions for any member, fitting, or appurtenance, the gage of metal or dimensions thereof shall be as required to fully develop the strength of the members whose gages and dimensions are given and which are used in structural combination.

All members, fittings, and appurtenances shall be designed as integral units or parts of the whole assembly.

CONSTRUCTION

612.03.01 Fabrication. Metal bin-type retaining walls shall consist of a plurality of pairs of columns, one column of each pair being in the plane of the front and the other column being in the plane of the rear of the wall, with the pairs of columns spaced longitudinally with overlapping

S-shaped facing and rear members (stringer) and transversely with overlapping U-shaped tie members (spacers). The necessary bolts and appurtenances shall be furnished for complete assembly of the units into a continuous closed face wall of connected bins.

All members shall be so fabricated that members of the same nominal size shall be fully interchangeable. The members shall be so fabricated and punched that no drilling, punching, or drifting to correct defects in manufacture will be required during field assembling and any members having improperly punched holes will be rejected and shall be replaced with properly punched members.

612.03.02 Earthwork. Rough excavation for the site of the wall shall be made to the elevation of the finished ground line at the face of the wall. Below this point, trenches eighteen (18) inches in width shall be excavated for the four sides of the bin. The bearing of the base of the bin shall be firm and shall be approved by the Engineer before erection of the wall.

Structure excavation and backfill for the interior of the bin and behind the wall shall conform to the requirements of Sections 206, "Structure Excavation" and 207, "Backfill." Backfilling behind the wall shall progress with the filling of the bins and shall not be carried ahead of the binfill. Existing slopes, which are shaped so as to cause a wedge action in the backfill, shall be step-cut or benched before backfilling. The limiting dimensions of structure backfill behind the wall shall be the same as those prescribed in subsection 207.04.01 for walls and abutments, or as otherwise shown on the plans.

612.03.03 Assembly. In the construction of a wall on a curve the proper curvature for the face shall be obtained by the use of shorter stringers in the front or rear panels of retaining walls as designated in the plans or by the Engineer.

The wall height and depth may be varied. Two or more designs of retaining walls may be incorporated in the same wall by the use of standard split columns to make the connection on the step-back.

The units shall be erected as shown on the plans. Members shall be handled carefully and any which are damaged shall be removed and new members substituted at the Contractor's expense.

METHOD OF MEASUREMENT

612.04.01 Measurement. The quantity of metal bin-type retaining wall measured for payment will be the number of square feet shown on the plans for each design type of wall, complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

612.05.01 Payment. The accepted quantities of metal bin-type retaining walls measured as provided in subsection 612.04.01, "Measurement," will be paid for at the contract unit price bid per square foot for the type specified.

Structure excavation and structure backfill will be paid for in accordance with Sections 206, "Structure Excavation" and 207, "Backfill."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Metal Bin-Type Retaining Wall (type)	Square Foot

SECTION 613

CONCRETE CURBS, GUTTERS, AND SIDEWALKS

DESCRIPTION

613.01.01 General. This work shall consist of constructing curbs, gutters, sidewalks, local depressions, and driveways of the form and dimensions shown on the plans of Class A or Class AA concrete as shown in the proposal, mixed and placed as provided in Sections 501, "Portland Cement Concrete" and 502, "Concrete Structures," of these specifications with the following modifications and additional requirements.

MATERIALS

613.02.01 General. Materials shall conform to the applicable requirements of Sections 501, "Portland Cement Concrete," 502, "Concrete Structures," and 505, "Reinforcing Steel."

CONSTRUCTION

613.03.01 Earthwork. The subgrade shall be constructed true to grade and cross section as shown on the plans or established by the Engineer. It shall be thoroughly watered and rolled or hand tamped until the subgrade reaches the compaction required for the adjacent roadway or base course. All soft and spongy material shall be removed to a depth of not less than six (6) inches below subgrade elevation for curbs, gutters, local depressions, and driveways and three (3) inches below for sidewalks, and the resulting space filled with earth, sand, or gravel of a quality that, when moistened and rolled or tamped, will form a firm and solid foundation.

The completed subgrade shall be tested for grade and cross section by means of a template extending the full depth and supported on the side forms. The subgrade and forms shall be thoroughly watered in advance of placing concrete.

613.03.02 Existing Curbs, Gutters, and Sidewalks. Where the plans provide for reconstruction of existing curb

and sidewalk and the limit of new work specified does not fall on a scoring line, the entire section shall be removed and the new curb and sidewalk shall join the old curb and sidewalk at the first scoring line beyond said specified limit.

613.03.03 Forms. The depth of forms for curbs shall be equal to the full depth of the curb. The depth of outside forms for concrete gutters shall be equal to the full thickness of the gutter. Timber forms, if used, shall be surfaced on the side placed next to the concrete, and shall have a true smooth upper edge, and shall not be less than one and five-eighths (1⅝) inches thick after being surfaced. Warped forms and forms not having a smooth, straight upper edge shall not be used.

Benders or thin plank forms, rigidly placed, shall be used on curves, grade changes, or for curb returns. Steel forms shall not be used on radii less than two hundred (200) feet.

Back forms for curb returns shall be made of one-half (½) inch benders, for the full height of the curb, cleated together. Forms shall be carefully set to alignment and grade and to conform to the dimensions required. Forms shall be held rigidly in place by the use of pairs of iron stakes placed at intervals not to exceed four (4) feet. If metal forms are used, iron stakes shall not be spaced more than six (6) feet apart. Clamps, spreaders, and braces shall be used where required to insure rigidity in the forms.

Forms shall not be removed until concrete has set sufficiently to prevent distorting or cracking.

All forms shall be cleaned thoroughly each time they are used and coated with a light oil as often as necessary to prevent the concrete from adhering to them.

613.03.04 Curb and Gutter Joints. Expansion joints one-half (½) inch wide shall be constructed in curbs and gutters at thirty (30) foot intervals and, in curbs, at the ends of all returns. Expansion joints shall be filled with joint filler strips one-half (½) inch thick conforming to the requirements of Section 707, "Joint Material" of these specifications. Expansion joint filler shall be shaped to the cross section of the curb and gutter.

Weakened plane joints shall be installed at ten (10) or fifteen (15) foot intervals, as directed by the Engineer, except that when Portland cement concrete pavement is adjacent thereto, or to be constructed adjacent thereto, they shall be installed continuously with the weakened plane joints in the adjacent pavement. Weakened plane joints shall be constructed to a minimum depth of one (1) inch by scoring with a tool which will leave the corners rounded and insure a free movement of the concrete at the joint.

Expansion joints and weakened plane joints shall be constructed at right angles to the line of the curb and gutter.

613.03.05 Sidewalk Expansion Joints. Transverse expansion joints one-half (½) inch wide shall be constructed at all sidewalk returns and opposite expansion joints in adjacent curb. Where curb is not adjacent, expansion joints shall be constructed at intervals of thirty (30) feet.

Expansion joints shall be filled with joint filler strips one-half (½) inch thick conforming to the requirements of Section 707, "Joint Material," of these specifications.

The joint filler shall be placed with the top edge one-fourth (¼) inch below the surface and shall be held in place by means of steel pins driven into the subgrade and spaced sufficiently close to prevent warping of the filler during floating. Upon completion of floating, the pins shall be removed and a suitable metal channel having legs not over three-fourths (¾) inch long shall be fitted snugly over the joint filler. The metal channel shall remain in place until the finishing operations have been completed, after which it shall be removed and the joint edged with an edging tool having a radius of one-eighth (⅛) inch.

613.03.06 Curb and Gutter Construction. In constructing curbs, entrances for garages or driveways shall be constructed according to the dimensions shown on the plans.

With the approval of the Engineer, the curb may be constructed by the use of a curb forming machine.

The installation of precast concrete curbing shall meet the requirements herein prescribed.

Where plantmixed surfacing is to be placed around or adjacent to manholes, drop inlets or catch basins in gutter, local depression or driveway areas, such structures shall not be constructed to final grade until after the curbs and gutters have been constructed for a reasonable distance, as directed by the Engineer, on each side of the structure, in order to maintain a true grade for the surfacing to match.

Where Portland cement concrete pavement is to be placed around or adjacent to manholes, drop inlets, or catch basins in gutter, local depression, or driveway areas, such structure shall not be constructed to final grade until after the concrete pavement has been constructed.

Concrete curbs to be constructed over an existing pavement shall be anchored to the pavement by means of steel dowels firmly grouted, with 1:1 Portland cement grout, in holes drilled in the pavement. Dowels shall conform to the requirements of bar reinforcing steel of these specifications and shall be spaced and be of the size and length as shown on the plans. Approved expansion bolts may be used in lieu of dowels, at the option of the Contractor.

The forms shall be filled to the top and the concrete shall be so handled that there will be no rock pockets. Concrete may be compacted by means of mechanical vibrators approved by the Engineer. Immediately after removing the front curb forms, the face of the curb shall be troweled smooth to a depth of not less than two (2) inches below the flow line or to the flow line of integral curb and gutter, and then finished with a steel trowel. The top shall be finished and the front and back edges rounded as shown on the plans.

After the face of the curb has been troweled smooth, it shall be given a final fine brush finish with brush strokes parallel to the line of the curb.

The top and face of the finished curb shall be true and straight, and the top surface of curbs and gutters shall be of uniform width, free from humps, sags, or other irregularities. When a straightedge ten (10) feet long is laid on the top or face of the curb or on the surface of gutters, the

surface shall not vary more than one-eighth (⅛) inch from the edge of the straightedge, except at grade changes or curves.

The exposed surfaces shall be cured in accordance with the requirements of Section 502, "Concrete Structures."

613.03.07 Sidewalk Construction. The structures shall be finished to smooth and uniform texture by troweling and by bloating with wooden floats, and, if so directed by the Engineer, by cross-brooming or burlap-finishing. The surface shall be lightly grooved or marked into squares or other shapes to match other such markings on similar existing structures in the vicinity, or as designated by the Engineer.

When a ten (10) foot straightedge is placed on the sidewalk, the surface shall not vary more than one-eighth (⅛) inch from the edge of the straightedge, except at grade changes, and the finished surface shall be free from blemishes.

Immediately after the surface of the sidewalk is finished, the concrete shall be cured in accordance with the requirements of Section 502, "Concrete Structures."

METHOD OF MEASUREMENT

613.04.01 Measurement. The quantity of curb, gutter, shoulder strip, mountable curb, and combination curb and gutter measured for payment will be the number of linear feet along the base of the curb face or along the flow line of the gutter, and such measurement shall be continuous along such line extended across driveway and alley entrance returns.

The quantity of sidewalk, driveway, loading zone, and steps shall be measured for payment by area in square yards.

In the case of integral curb and walk, the width of the walk shall extend to the back face of the curb. In the case of steps, the area measured shall be the summation of the areas of the treads, computed by multiplying the width of the tread by the length of the tread out to out of integral wall, if any.

All quantities measured for payment herein will be complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

613.05.01 Payment. The accepted quantities of concrete measured as provided in subsection 613.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for curb, gutter, shoulder strip, or mountable curb and per square yard for sidewalk, driveway, loading zone, or steps as the case may be.

All excavation and base course work required for and performed during construction of the items of this section will be paid for as provided in the respective sections of the specifications; however, when the contract does not provide bid items for excavation or base course, such work required and performed will be considered subsidiary to the pay item contained herein and no further payment will be made therefor.

Any excavation or backfill required other than roadway quantities will be considered subsidiary to the major items of work and no further payment will be made therefor.

Reinforcing steel placed in curbs and gutters as shown on the plans or ordered by the Engineer will be paid for as provided in Section 506, "Steel Structures."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(class) Concrete Curb	Linear Foot
(class) Concrete Gutter	Linear Foot
(class) Concrete Curb and Gutter	Linear Foot
(class) Concrete Sidewalk	Square Yard
(class) Concrete Driveway	Square Yard
(class) Concrete Sidewalk and Driveway	Square Yard
(class) Concrete Scored Shoulder Strip	Linear Foot
(class) Concrete Mountable Curb	Linear Foot
(class) Concrete Loading Zones	Square Yard

SECTION 614

PAINTING

DESCRIPTION

614.01.01 General. This work shall consist of the preparation of surfaces to be painted and the application, protection, and drying of the required number of coats of paint of the kinds and at the points specified or ordered by the Engineer.

MATERIALS

614.02.01 General. All materials shall meet or exceed the minimum standards hereinafter set forth:

(a) Raw Materials. American Society for Testing Materials (ASTM) and Federal Specifications.

(b) Prepared Paints. Federal Specifications are specified to designate the type of material and standard of quality. Manufacturer's standard, first grade materials meeting or exceeding these requirements may be used if approved by the Engineer. Materials not bearing manufacturer's identification as a standard, first grade product, of his regular line, will not be considered.

(c) Proprietary materials when specified hereinafter by the manufacturer's trade name designate the standard of quality and type of material required. When the quality or type of material required is not specified, the Contractor shall apply for directions as to selection of materials and receive approval thereof from the Engineer before proceeding; only the best quality of such materials shall be used, as determined by the Engineer.

(d) Materials lists shall be submitted to the Engineer for approval and none shall be used until such approval has been obtained. All materials proposed for use shall be delivered to the site in original containers, seals unbroken, stored where directed, and none may be used until approved by the Engineer. Materials that are not approved must be immediately removed from the jobsite.

614.02.02 Number of Coats. Unless otherwise required in the contract documents, the number and kinds of coats of paint shall be as set forth in Section 714, "Paint."

CONSTRUCTION

614.03.01 Weather Conditions. Paint shall be applied only on thoroughly dry surfaces and during periods of favorable weather. Except as provided below, painting will not be permitted when weather conditions during applications are such that the atmospheric temperature is at or below forty (40) degrees Fahrenheit or when freshly painted surfaces may become damaged by rain, wind, dust, or condensation, or when it can be anticipated that the atmospheric temperature will drop below forty (40) degrees Fahrenheit, during the drying period. If fresh paint is damaged by the elements it shall be replaced by the Contractor at his expense.

Subject to the approval of the Engineer in writing, the Contractor may provide suitable enclosures to permit painting during inclement weather. Provisions must be made to control atmospheric conditions artificially inside the enclosures within the limits suitable for painting throughout the painting operation. The cost of providing and maintaining such enclosures shall be considered as included in the prices paid for the various contract items of work and no additional payment will be made therefor.

614.03.02 Application—General. All work shall be done by painters and finishers of established status and reputation for executing their work by the very best methods for each kind or type. Painting shall not be done except when the surface is dry and when weather conditions are satisfactory as set forth above.

Strict adherence to these specifications and the recommendations of the manufacturer whose materials are used shall be followed in the application. The Contractor shall use such skills, equipment, materials, and give his thorough attention to details as will provide thoroughly workmanlike and satisfactory results throughout.

Work which shows carelessness, lack of skill and execution, or which is defective due to any other cause shall be removed and refinished or repainted as directed without additional cost to the State.

On all surfaces which are inaccessible for brushing, the paint shall be applied by sheepskin daubers especially constructed for the purpose, or by other means approved by the Engineer.

If spray methods are used, the operator shall be thoroughly experienced. Runs, sags, thin areas in the paint coat, or skips and holidays shall be considered as evidence that the work is unsatisfactory and the Contractor may be required to apply the remainder of the paint by brush.

Mechanical mixers shall be used to mix the paint. The paint shall be mixed a sufficient length of time, prior to use, to thoroughly mix the pigment and vehicle together. Paint shall be kept thoroughly mixed while being applied, to keep the pigments in suspension.

Paint specified or formulated shall be ready for application and thinning will be allowed only on direction of the Engineer.

The Contractor shall protect all parts of the structure being painted against disfigurement by spatters, splashes, and smerches of paint or paint materials. When paint is being applied on structures carrying public traffic, the Contractor shall be responsible for any damage caused by his operations to passing vehicles or persons and may be required to use canvas shields or other protective means to guard against such damage.

Paint stains which result in an unsightly appearance shall be removed by the Contractor at his own expense.

614.03.03 Surface Preparation of Steel. The following methods of surface preparation apply to steel surfaces. Unless otherwise specified, the sandblasting method shall be used.

(a) Sand Blasting. All dirt, mill scale, rust, stain, old paint, and other foreign matter shall be removed from steel surfaces by an approved sandblast apparatus. Sand

blasting shall be sufficient to give the surface the appearance of unpolished cast aluminum. Only sharp, dry sand of proper grading to give satisfactory results shall be used.

Unwashed beach sand containing salt or excessive amounts of silt will not be allowed.

When sandblasting is being performed on structures open to traffic, the Contractor shall provide suitable protective devices to prevent damage to traffic.

When sandblasting is being performed near machinery, all journals, bearings, motors and moving parts shall be sealed against entry of sand dust before sandblasting begins.

Unless otherwise authorized by the Engineer, sandblasted surfaces shall be primed or treated the same day sandblasting is done. If cleaned surfaces rust before painting is accomplished, they shall be recleaned by the Contractor.

(b) Washes. Rust-inhibitor chemical washes shall be applied to freshly sandblasted steel surfaces prior to the application of the first undercoat of paint. Washes shall be applied in not more than four (4) hour intervals. If in the opinion of the Engineer, atmospheric conditions are such that corrosion products form on freshly sandblasted surfaces in less than four (4) hours, treatment may be required at more frequent intervals.

Rust-inhibitor chemical washes may be applied by brush or spray, and they shall be applied in a careful manner to insure that all surfaces are covered.

During the application of the rust-inhibitor chemical wash no sandblasting will be permitted to the areas being treated.

No paint shall be applied until after the treated surfaces have thoroughly dried.

The first undercoat of paint shall be applied to the treated surfaces the same day that cleaning and washing have been done.

(c) Steam Cleaning. All dirt, grease, loose chalky paint, or other foreign material which has accumulated on the previously painted surfaces shall be removed with

an approved steam cleaning apparatus which shall precede all other phases of cleaning.

It is not intended that sound paint be removed by this process. Subsequent painting shall not be performed until the cleaned surfaces are thoroughly dry and in no case in less than twenty-four (24) hours after cleaning.

A detergent soap consisting of forty-five (45) percent sodium metasilicate, forty-three (43) percent sodium sesquisilicate, ten (10) percent sodium tetraphosphate and two (2) percent Naccanol shall be added to the feed water of the steam generator at the approximate rate of one (1) pound of detergent per two hundred (200) pounds of water.

Any residue which may accumulate on cleaned surfaces shall be removed by flushing with fresh water but washing down the cleaned surfaces will not otherwise be required.

(d) Hand Cleaning. All dirt, loose rust, and mill scale, dead paint, or paint which is not firmly bonded to the metal surfaces shall be removed by wire brushes, either hand or powered, hand scraping tools or sandpaper.

Pneumatic chipping hammers will not be allowed unless authorized in writing by the Engineer. Hand cleaning shall be sufficient to remove all loose material which would prevent the bond of succeeding coats of paint.

614.03.04 Painting Structural Steel. (a) Paint. Unless otherwise required in the contract documents, the paints to be applied to steel surfaces shall conform to the requirements of Section 714, "Paint." The undercoats shall consist of a minimum dry film thickness of one (1) mil per coat. The finish coat shall consist of a minimum dry film thickness of one (1) mil. The total thickness of all coats shall be not less than three (3) mils.

Excessively thick coats of paint will not be permitted. The thickness of each coat shall be limited to that which will result in uniform drying throughout the paint film.

(b) Field Cleaning. Unless otherwise specified in the contract documents, after erection and riveting or welding, all surfaces of unpainted structural steel which will be

exposed to air, shall be sandblasted in accordance with the requirements of subsection 614.03.03, "Surface Preparation of Steel."

Any damage to sound paint, on areas not designated for treatment, resulting from the Contractor's operations, shall be repaired to the satisfaction of the Engineer.

(c) Painting. Painting of structural steel prior to erection will be limited to surface preparation and one undercoat of paint. Any deficiencies in the first coat of paint shall be corrected to the satisfaction of the Engineer, prior to the application of succeeding coats of paint.

Surfaces exposed to the atmosphere which would be inaccessible for painting after erection shall be painted the full number of coats prior to erection.

The surface of the paint coat being covered shall be free from moisture, dust, grease, or any other deleterious material which would prevent the bond of the succeeding paint coats. In spot painting, any old paint which lifts after application of the first spot coat, shall be removed by scraping and the area repainted before application of the next coat.

The application of the finish coat will not be permitted until the required total film thickness of the undercoats of paint, as described in (a), above, is obtained.

Open seams at contact surfaces of built-up members which would retain moisture shall be caulked with red lead paste before applying the second undercoat of paint.

Metal surfaces embedded in concrete need not be painted.

(d) Machine Finished Surfaces. With the exception of abutting chord and column splices and column and truss shoe bases, machine finished surfaces shall be coated with a rust inhibitor which can be easily removed. Surfaces of iron and steel castings which have been machine finished shall be painted with a coat of shop paint.

(e) Frames and Grates. Prior to installation, all surfaces of frames and grates exposed to the atmosphere shall be painted with two coats of paint. Unless otherwise specified in the contract documents, the exposed surfaces

shall be painted after installation with one finish coat as specified for structural steel.

614.03.05 Painting Timber. (a) Paint. All new timber requiring painting shall be painted with three coats of paint. The paint used for various coats will be as specified in these specifications or in the contract documents.

(b) Preparation of Surfaces. All cracked or peeled paint, loose chalky paint, dirt, and other foreign matter shall be removed by wire brushing, scraping, or other approved means immediately prior to painting. Unpainted timber shall be thoroughly dry before paint is applied.

(c) Painting. When permitted in writing by the Engineer, the first coat of paint may be applied prior to erection.

After the first coat has dried and the timber is in place, all cracks, checks, nail holes, etc., shall be puttied flush with the surface and allowed to dry before the second coat is applied.

Skips, holidays, thin areas, or other deficiencies in any one coat of paint shall be corrected to the satisfaction of the Engineer before the succeeding coat is applied.

The surface of the paint coat being covered shall be free of any deleterious material before any additional paint is applied.

BASIS OF PAYMENT

614.05.01 Payment. No direct payment will be made for painting, cleaning structural steel, or preparing surfaces for painting. Compensation for this work shall be considered as included in the contract unit prices bid for the particular item requiring painting.

SECTION 615

PRESERVATIVE TREATMENTS FOR TIMBER

DESCRIPTION

615.01.01 General. This work shall consist of preservative treatment for lumber, timber, and piles as herein specified.

MATERIALS

615.02.01 General. The materials used shall be those prescribed for the several items which constitute the finished work and shall comply with all the requirements for such materials as set forth in these specifications.

Attention is directed to Section 719, "Timber Preservatives."

CONSTRUCTION

615.03.01 Treatment. All structural timber, piling, and other lumber shall be thoroughly seasoned or conditioned before treatment by air seasoning, kiln drying, steaming, or heating in the preservative, either at atmospheric pressure or under a vacuum, or by a combination thereof that will not cause damage. The moisture remaining in the wood, prior to treatment, shall be reduced so that the injection and proper distribution of the required amount of preservative will be obtained. The method of seasoning, conditioning and treating used shall conform to the Federal Specification TT–W–571.

615.03.02 Amount of Preservative. The minimum amount of preservative retained per cubic foot of timber, lumber, or piling shall conform to the minimum specification requirements of the Federal Specification TT–W–571.

Unless otherwise specified, material treated with pentachlorophenol shall have a minimum retention of eight (8) pounds unless it is to be painted, then six (6) pounds will be the minimum retention.

Material to be treated with Ammoniacal Copper Arsenite shall have a net retention of dry salts of not less than 0.3 pounds.

615.03.03 Preservative Treatment by the Hot-Cold Soaking Method. When called for on the plans, all lumber and timber to be treated by the hot-cold soaking method must be reasonably well seasoned and free from outer and inner bark, dirt, grease, or other objectionable matter which will in any way hinder the free penetration of the preservative. All lumber and timber of two (2) inch dimensional stock or larger shall be incised and all framing shall be done before treatment.

The preservative used shall be a five (5) percent concentration of pentachlorophenol.

The tanks used shall be of sufficient size to permit complete submergence of the largest timber in any operation and to allow free circulation of the liquid around the timber being treated. Sufficient liquid shall be maintained in the tank to completely submerge the timber to a minimum depth of six (6) inches. When a number of pieces are being treated at one time, each piece shall be separated from the others on all sides by spacers not less than one-fourth (¼) inch in least dimension. Suitable weights or cross bracing shall be provided to keep the material submerged.

The timber or lumber shall be submerged in the cold solution as previously described. The temperature shall be slowly increased for a period of not less than five (5) hours to a minimum temperature of one hundred eighty (180) degrees Fahrenheit and not exceeding two hundred ten (210) degrees Fahrenheit. After five (5) hours and attaining the minimum specified temperature, the timber or lumber shall be permitted to cool in the solution until such time as the minimum specified quantity of preservative is absorbed by the wood.

Timber for minor irrigation structures, unless otherwise shown on the plans, shall be No. 1 Common grade of the species permitted, and shall be treated in accordance with the Hot-Cold Soak Process. The species permitted and the minimum retention in pounds per cubic foot required are as follows:

Species	Min. Retention Per Cubic Foot (pounds)
Douglas Fir (Rocky Mountain, Inland, or Coast)	2.0
Pine, Yellow (Pinus Ponderosa)	4.0
Pine, Lodge Pole (Pinus Contorta)	4.0
Cottonwood, Northern Black (Populus Trichocarpa Hastata)	4.0

615.03.04 Inspection. All timber and piling, untreated or to be treated, shall be inspected before treatment by an inspector designated by the Engineer. The inspector shall stamp each piece of timber accepted with a stamp making a legible mark designating the inspector.

All timber and piling shall be inspected after treatment by an inspector designated by the Engineer. The inspector shall stamp each piece accepted with a stamp making a legible mark designating the inspector.

All materials and processes used in the manufacture of material shall be subjected to inspection, acceptance, or rejection at the manufacturer's plant, which shall be equipped with all the necessary gages, appliances and facilities to enable the inspector to satisfy himself that the requirements of the specifications have been fulfilled.

The treated timber and piling shall be free from heat checks, water bursts, excessive checking, results of chafing or from other damage or defects which would impair its usefulness or durability.

BASIS OF PAYMENT

615.05.01 Payment. Full compensation for treatment of lumber, timber, and piles as herein specified shall be considered as included in the price paid for the particular item of work in which the treated lumber, timber, or piling is used and no additional allowance will be made therefor.

SECTION 616

FENCING

DESCRIPTION

616.01.01 General. This work shall consist of furnishing and erecting new standard fence, chain-link fence, gates, or reconstructing fences previously removed, in conformity with these specifications and the plans.

New standard fence shall consist of galvanized barbed wire, galvanized farm fence or both fastened to wood posts or metal posts or to a combination of the two kinds of posts as shown on the standard plans.

Chain-link fence shall consist of galvanized chain-link fabric attached to metal posts and fastened to a top tensioning cable and a bottom tensioning wire. The height of chain-link fences shall be as designated in the contract documents.

MATERIALS

616.02.01 General. Materials shall conform to the requirements specified in Sections 724, "Fence Materials" and 501, "Portland Cement Concrete."

CONSTRUCTION

616.03.01 General. All trees, brush, and other obstructions which interfere with proper construction of fences shall be removed and disposed of in accordance with the requirements of Section 201, "Clearing and Grubbing," of these specifications except that no payment will be made for such work. When constructing chain-link fence, rocks and other surface irregularities that require moving in order to maintain a nearly smooth surface, shall be removed and no direct payment will be made therefor.

Fence construction operations shall be so conducted as to prevent the escape of livestock. Existing cross fences shall be connected to the new fence. Corner posts, with braces for every direction of strain, shall be placed at the junction with existing fences and the wire in both fences properly fastened to the posts. At bridges and cattle passes,

and at culverts if shown on the plans or ordered by the Engineer the new fence shall be connected to the structure in such a manner as to permit the free passage of livestock through or under the structure.

Barbed wire, farm fence, and chain-link fence fabric shall be fastened on the side of the posts opposite the highway centerline unless otherwise directed by the Engineer.

616.03.02 Standard Fence. Standard fencing shall be designated by types as follows: Metal posts—Type A; Wood posts—Type B; Combination metal and wood posts —Type C. The type of fence construction shall be as shown on the plans and indicated in the proposal. Posts shall be firmly set or driven into the ground and spaced as indicated on the plans. Each end, corner, and gate post shall be firmly braced and shall be set in concrete when required. Posts shall be braced as indicated on the plans.

Standard fencing will be designated not only by type, but also by a symbol indicating the fencing required. Thus (Type A–832–3B) will be used to designate a fence composed of metal posts, thirty-two (32) inch woven wire (farm fencing) and three barbed wires; (Type C–726–4B) to designate a fence composed of a combination of metal and wood posts twenty-six (26) inch woven wire and four barbed wires, etc. The figures 832, etc., when they appear in the symbol, correspond to design numbers set forth in the standard plan.

In general, in determining the post spacing, measurements will be made parallel to the slope of the natural ground, and all posts shall be placed in vertical position except in unusual locations where in the opinion of the Engineer it would be more satisfactory to place the posts perpendicular to the slope of the ground. All intervals shall be measured center to center of adjacent posts.

Changes in line where the angle of deflection is thirty (30) degrees or more shall be considered as corners and corner posts shall be installed. Changes in line where the angle deflection is more than fifteen (15) degrees and less than thirty (30) degrees shall be considered as alignment angles and adjacent posts shall be made fast to the angle posts by means of wire, or if such method is impracticable

in the opinion of the Engineer, such posts shall be braced as above specified for bracing gate, end and corner posts.

At all grade deflections and alignment angles where stresses tend to pull the posts from the ground, the fencing shall be snubbed or guyed at the critical point by means of a double strand of nine (9) gage galvanized wire connected to each horizontal line of barbed wire or to the top and bottom of wire mesh fabric, and to a deadman weighing approximately one hundred (100) pounds, buried in the ground not less than two (2) feet. The fencing shall be pulled snug close to the ground before being snubbed or guyed.

Barbed wire and farm fence fabric (woven wire) shall be stretched taut and securely fastened to each post by means of suitable devices approved by the Engineer.

616.03.03 Chain-Link Fence. All posts shall be of a total length of not less than the depth of the concrete footing as shown on the plans, plus the length required above ground.

Changes in line where the angle of deflection is thirty (30) degrees or more shall be considered as corners and corner posts shall be installed.

Between posts, chain-link fences shall be fastened to a bottom tension wire and a top tension cable. The bottom tension wire shall be at least seven (7) gage galvanized coil spring wire of good commercial wire. The top tension cable shall be at least three-eighths (⅜) inch diameter galvanized seven strand cable conforming to the requirements of the current ASTM Designation A122, common grade.

Line posts shall be spaced at not more than ten (10) foot intervals, measured from center to center of posts. In general, in determining the post spacing, measurements will be made parallel to the slope of the natural ground, and all posts shall be placed in a vertical position except in unusual locations where in the opinion of the Engineer it would be more satisfactory to place the posts perpendicular to the slope of the ground.

All metal posts shall be set in Class A or AA Portland cement concrete footing crowned at the top to shed water. Depths of footings shall be as shown on the plans.

End, corner, and gate posts shall be braced with galvanized braces used as compression members and galvanized steel truss rods with truss tighteners used as tension members. Line posts, at intervals of five hundred (500) feet, shall be braced and trussed in both directions as shown on the plans.

The fabric shall be stretched taut and securely fastened to the posts, and between posts the top edge of the fabric shall be fastened to the top tension cable and the lower edge fastened to the bottom tension wire. Tension cable and wire shall be stretched tight with truss tightener as shown on the plans. The bottom tension wire shall be installed on a straight grade between posts by excavating the high points of the ground and in no case will filling of depressions be permitted.

The fabric shall be fastened to the end, corner, and gate posts with one-fourth by three-fourths inch (¼″ x ¾″) steel stretcher bars and not less than one-eighth by three-fourths inch (⅛″ x ¾″) steel stretcher bar bands placed at one (1) foot intervals; and to line posts tension cable and tension wires with tie wires or metal bands. Tie wires or metal bands shall be spaced on line posts at intervals of approximately fourteen (14) inches and on tension cables and tension wires approximately eighteen (18) inches.

All posts shall be fitted with tops designed so as to fit securely over the posts, and carry the top tension cable, except that the top of the H-section posts may be open-slotted in such a manner as to securely hold the top tension cable in position without vertical movement. Such slotting shall allow removal and replacement of a post without disturbing the top tension cable. Tubular posts shall be fitted with watertight tops.

616.03.04 Reconstruct Fence. Reconstructed fences shall be carefully erected, using salvaged materials and shall be similar in type to the original construction. Any new materials necessary to rebuild the fence shall be furnished by the Contractor, shall be of the same kind as those in the original fence, and the cost thereof shall be included in the contract price for the work. The resulting reconstructed fence shall be equal to or better than before

removed. In reconstructed fences, the Department reserves the right to furnish the Contractor with such new materials as it deems advisable, and these materials shall be used in the reconstruction of the fence in lieu of salvage materials which they replaced.

616.03.05 Gates. The width of drive gates shall be as shown on the plans and as indicated in the proposal and the height shall be suited to the fencing but shall not be more than seventy-two (72) inches nor less than forty-eight (48) inches. The wire mesh filler shall be rectangular or two (2) inch diamond mesh for standard fencing and chain-link fence fabric for chain-link fencing.

Walk gates shall be three and one-half (3½) feet wide and of a height corresponding to the adjacent fence height.

The gates shall be hung by steel or malleable iron hinges so designed as to securely fasten to the gate posts and permit the gate to swing back against the fence.

Gates shall be provided with a combination steel or malleable iron catch and locking-in attachment of approved design. A center rest with catch shall be provided where required.

Missouri gates shall be constructed as shown on the standard plan.

METHOD OF MEASUREMENT

616.04.01 Measurement. The quantity of new fence measured for payment will be the number of linear feet, exclusive of gates and cattle guards, complete and in place.

The quantity of reconstructed fence measured for payment will be the number of linear feet, including used gates, complete and in place.

The quantity of new gates measured for payment will be the number of gates complete and in place. If more than one size or type of gate is involved, separate measurement will be made for each size and type given. Missouri gates will not be measured as units, but will be considered an integral part of the fence.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

616.05.01 Payment. The accepted quantity of new and reconstructed fence measured as provided in subsection 616.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for the types and sizes specified.

The accepted quantity of new gates measured as provided in subsection 616.04.01, "Measurement," will be paid for at the contract unit price bid per each for types and sizes specified.

The above prices shall be full compensation for furnishing hardware, cement, concrete, framing, erecting, connecting fence, and all incidentals necessary to complete the work.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Type (.....) Fence	Linear Foot
(size) Chain Link Fence	Linear Foot
(size) Metal Drive Gate	Each
(size) Timber Drive Gate	Each
(size) Metal Walk Gate	Each
(size) Timber Walk Gate	Each
Reconstruct Fence	Linear Foot

SECTION 617

CATTLE GUARDS

DESCRIPTION

617.01.01 General. This work shall consist of furnishing and constructing standard steel cattle guards and cattle guard wings of the design and at points shown on the plans or ordered by the Engineer.

MATERIALS

617.02.01 General. All materials shall conform to the requirements specified in the following sections:

Portland Cement Concrete	Section 501
Reinforcing Steel	Section 505
Steel Structures	Section 506
Hardware	Section 723
Painting	Section 614
Paint	Section 714

Portland cement concrete shall be Class A or Class AA, unless otherwise provided.

All hardware shall be galvanized steel.

All lumber and timber shall be Douglas Fir, 1100 #f No. 2 joist and plank or 1200 #c No. 1 posts and timber. Any commercial grading rules that will provide material of an equal or greater stress value may be used.

CONSTRUCTION

617.03.01 Earthwork. Structure excavation and backfill shall conform to the applicable requirements of Sections 206, "Structure Excavation" and 207, "Backfill."

617.03.02 General. Cattle guards shall be constructed in accordance with the details and dimensions shown on the plans.

Concrete and metal reinforcement construction shall conform to the applicable requirements of Sections 502, "Concrete Structures" and 505, "Reinforcing Steel," respectively.

Steel member connections shall be welded and the construction thereof shall conform to Section 506, "Steel Structures."

The wing posts and wheel guards shall be given a preservative treatment conforming to the requirements of Section 719, "Timber Preservatives." Treated timber and lumber is not to be painted.

Timber and lumber shall be assembled and placed in conformance to the applicable requirements of Section 507, "Timber Structures."

Painting shall be in accordance with recognized high standards of workmanship and in conformance with the applicable requirements of Section 614, "Painting."

METHOD OF MEASUREMENT

617.04.01 Measurement. The quantity to be measured for payment will be the number of steel cattle guards or cattle guard wings complete and in place. If more than one size of cattle guard is involved, separate measurement will be made of each size given.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

617.05.01 Payment. The accepted quantity of cattle guards measured as provided in subsection 617.04.01, "Measurement," will be paid for at the contract unit price bid per each for the sizes specified. The cost of cattle guard wings shall be included in the contract unit price for cattle guards, however, where wings alone are required, they will be paid for at the contract unit price each for cattle guard wings. The above prices shall be full compensation for furnishing hardware, cement concrete, steel, timber and lumber, structure excavation and backfill, furnishing and applying paint, framing, erecting, adjusting fence, and all incidentals necessary to complete the work.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) Steel Cattle Guard	Each
Cattle Guard Wings	Each

SECTION 618

GUARDRAIL

DESCRIPTION

618.01.01 General. This work shall consist of furnishing and erecting new guardrail, or reconstructing guardrail previously removed, in conformity with these specifications and of the types and at the points shown on the plans or ordered by the Engineer. This item shall also consist of furnishing and installing reflector plates as shown on the plans.

MATERIALS

618.02.01 General. All material shall conform to the requirements specified in the following sections:

Timber	Section 718
Timber Preservatives	Section 719
Guardrail Materials	Section 720
Galvanizing	Section 715

Each post, after fabrication, shall be given a preservative treatment by pressure processes with one of the following in accordance with the provisions of Section 615, "Preservative Treatments for Timber."

The minimum retention of preservative in pounds per cubic foot of wood shall be as follows:

(a) Creosote—8 pounds
(b) Creosote-Petroleum—8 pounds
(c) Pentachlorophenol—8 pounds

618.02.02 Reflectors. Reflector plates for guardrail shall be fabricated from sixteen (16) gage steel sheet or eighty thousandths (0.080) inch thick aluminum sheet, alloy 6061–T6. Nails for fastening reflector plates to the guardrail post shall be either galvanized metal or aluminum. Steel reflector plates shall be galvanized. Reflectorized material for reflector plates shall conform to the requirements of subsection 721.03.03, "Reflectors."

CONSTRUCTION

618.03.01 General. Unless otherwise specified, guardrail shall be constructed with either treated Douglas Fir, West Coast Hemlock, or Western Larch posts, beam-type plates and fittings, as shown on the plans. Post spacing shall be as shown and guardrails shall be constructed in accordance with the design shown on the plans. The use of more than one type of guardrail on a single project will not be approved unless so provided in the special provisions or appearing as a contract item in the proposal.

Posts shall be set plumb, except on superelevated curves where they shall be set perpendicular to the roadbed. Front faces of posts shall form a straight line, except on curves where they shall be a uniform distance from the centerline of the roadway. Post holes shall be backfilled in layers with approved material thoroughly rammed with an iron tamping tool in such manner as not to displace the bottom of posts from correct alignment.

Workmanship shall be first class in all respects and framing shall be done and fittings attached in such manner that the rail, after erection, shall be true to line and grade and shall have the proper tension in the rail plates. Care shall be taken to prevent the disturbance of posts during the erection of the rail, and, when necessary, temporary braces shall be installed to insure against post displacement.

618.03.02 Painted Guardrail. After erection, all metal parts and fittings, free from coatings of any kind, including dirt, rust, and oil and grease, shall be given three coats of paint as specified in Section 714, "Paint." Parts shop prime coated by the manufacturer shall conform to subsection 614.03.04, "Painting Structural Steel" and Section 714, "Paint."

Posts shall not be painted.

All beams shall be cleaned prior to priming by wiping down the surface with solvents such as naphtha, white (lead-free) gasoline, or detergent. Detergents may be of the type commonly used in washing machines; however, if

detergent is used, it shall be thoroughly rinsed from the rail with clear water.

All loose white deposit shall be removed with a stiff brush (not steel), steel wool, or sandpaper. Care shall be exercised so as not to remove zinc coating.

Intermediate and finish coats shall be as specified in Section 614, "Painting." Surfaces to be painted shall be dry and the temperature during priming, painting, and for six (6) hours thereafter shall not be below fifty (50) degrees Fahrenheit.

After the posts are set, the exposed portions shall be wrapped or otherwise protected to the satisfaction of the Engineer so that they shall remain free from paint, road oil, and other objectionable material. After all other work is completed and prior to the semi-final inspection, the wrapping or protection shall be removed. All posts that have paint, road oil, or other objectionable materials on the exposed surface or that do not otherwise meet the required specifications shall be cleaned or removed, as the case may require, at the Contractor's expense.

All exposed surface of the metal guardrail that has become soiled or marred shall be cleaned or repainted at the expense of the Contractor as required by the Engineer.

After the rail has been painted as specified, nuts fastening rail plate to springs shall be backed off slightly so that the connection is firm but not tight and will permit the slight movement necessary to absorb expansion and contraction of the rail.

618.03.02 Galvanized Guardrail. The guardrail beam elements and end sections shall be galvanized. Galvanizing shall be performed after fabrication. Fabrication shall include all operations such as shearing, cutting, punching, forming, drilling, milling, and bending.

Galvanized surfaces that are abraded or damaged at any time after the application of the zinc coating shall be repaired by thoroughly wire brushing the damaged areas and removing all loose and cracked coating, after which the cleaned areas shall be painted with two coats of paint,

high zinc dust content, conforming to the requirements of Federal Specification MIL-P-21035.

All exposed surface of the metal guardrail that has become soiled shall be cleaned, at the expense of the Contractor, as required by the Engineer.

618.03.03 Reconstructed Guardrail. Reconstructed guardrail shall be carefully erected using salvaged materials and shall be similar in type to the original construction. Any new materials necessary to rebuild the guardrail shall be furnished by the Contractor, shall be of the same kind as those in the original, if available, and the cost thereof shall be included in the contract price for the work. The Department reserves the right to furnish the Contractor with such materials as it deems advisable, and these materials shall be used in the reconstruction of the guardrail in lieu of salvage materials which they replaced.

Reconstructed guardrail shall be painted with one coat of paint after first touching up all spots on which the original paint has been removed or destroyed.

METHOD OF MEASUREMENT

618.04.01 Measurement. The quantity of new or reconstructed guardrail measured for payment will be the number of linear feet measured along the front face of the rail between centers of end posts, complete and in place. In the case of new guardrail an allowance of two (2) feet at each end post shall be added to the length measured between the centers of end posts when terminal sections are specified.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

618.05.01 Payment. The accepted quantity of new and reconstructed guardrail measured as provided in subsection 618.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot.

The above prices shall be full compensation for furnishing hardware, reflectors, erecting, painting, galvanizing, and all incidentals necessary to complete the work.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Painted Guardrail	Linear Foot
Galvanized Guardrail	Linear Foot
Reconstruct Guardrail	Linear Foot

SECTION 619

CULVERT MARKERS AND GUIDE POSTS

DESCRIPTION

619.01.01 General. This work shall consist of furnishing and installing culvert markers and guide posts of the design and at locations shown on the plans or established by the Engineer.

MATERIALS

619.02.01 General. Materials shall conform to the requirements specified in Section 721, "Culvert Marker and Guide Posts."

CONSTRUCTION

619.03.01 General. Target members and reflectors appropriate to the color involved shall be assembled, fastened, set, and aligned in accordance with the details and dimensions shown on the plans. All fastenings shall be tight.

The exact locations will be staked by the Engineer.

619.03.02 Reset. Reset culvert markers and guide posts shall be carefully erected, using salvaged materials, and shall be similar in type to the original construction. Any new materials necessary to rebuild the markers shall be furnished by the Contractor, shall be the same kind as those in the original, if available, and the cost thereof shall be included in the contract price for the work. The Department reserves the right to furnish the Contractor with such new materials as it deems advisable, and these materials shall be used in the resetting of the markers in lieu of salvage materials which they replaced.

METHOD OF MEASUREMENT

619.04.01 Measurement. The quantity of new or reset culvert markers and guide posts measured for payment will be the number of markers ordered by the Engineer and placed by the Contractor.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

619.05.01 Payment. The accepted quantity of new and reset culvert markers and guide posts measured as provided in subsection 619.04.01, "Measurement," will be paid for at the contract unit price bid per each, which price shall be full compensation for furnishing hardware, erecting, and incidentals necessary to complete the work.

When the Engineer orders guide posts placed for the protection of the public traffic, and such order is prior to the time the Contractor would normally install them, and some posts subsequently are damaged by public traffic, the Contractor shall replace the damaged posts with new ones and receive compensation at the contract unit bid price for both the damaged posts and the ones replaced.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Culvert Markers and Guide Posts	Each
Reset Culvert Markers and Guide Posts	Each

SECTION 620

RIGHT OF WAY MARKERS

DESCRIPTION

620.01.01 General. This work shall consist of furnishing and erecting timber posts for right of way markers conforming to these specifications and of the design shown on the plans or ordered by the Engineer.

MATERIALS

620.02.01 General. All materials shall conform to the requirements specified in the following sections:

Timber	Section 718
Timber Preservatives	Section 719
Paint	Section 714

The posts shall be either Douglas Fir, Western Larch, or West Coast Hemlock treated with a preservative by pressure processes conforming to the requirements of Section 615, "Preservative Treatments for Timber."

CONSTRUCTION

620.03.01 General. Right of way markers shall be constructed in accordance with the details and dimensions shown on the plans. The markers shall be set plumb and the post hole shall be backfilled in layers with approved material thoroughly rammed with an iron tamping tool.

The exact location of posts will be staked by the Engineer.

METHOD OF MEASUREMENT

620.04.01 Measurement. The quantity of right of way markers measured for payment will be the number of markers complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

620.05.01 Payment. The accepted quantity of right of way markers measured as provided in subsection 620.-04.01, "Measurement," will be paid for at the contract unit price bid per each.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Right of Way Markers	Each

SECTION 621

MONUMENTS

DESCRIPTION

621.01.01 General. This work shall consist of furnishing and installing Portland cement concrete monuments and metal marker posts of the design and at locations shown on the plans or ordered by the Engineer.

Bronze disks furnished by the Department shall be installed in the monuments.

MATERIALS

621.02.01 General. Materials shall conform to the requirements specified in the following sections:

Portland Cement Concrete	Section 501
Fence Materials	Section 724

CONSTRUCTION

621.03.01 Installation. Monuments shall be constructed of Class A or AA Portland cement concrete, in accordance with the applicable provisions of Section 502, "Concrete Structures."

These monuments shall be set to assist in re-establishment of the centerline for future use and shall be set at the beginning and end of each project, at the beginning and end of each curve, and approximately one-half (½) mile apart on long tangents.

These monuments located as outlined above, shall be established outside construction limits, and the exact location will be that determined by the Engineer.

A hole just large enough for the monument shall be excavated for the required depth. If solid rock is reached before the required depth is reached, the monument may be built on this instead of being built to its full depth. This hole shall be filled with the concrete. When the concrete has set sufficiently, the bronze disk or a plug shall be installed in the exact position required by the Engineer.

Metal marker posts shall be "T" rail steel drive fence

posts complete with an anchor and not less than five (5) feet in length, weighing not less than one and three-tenths (1.3) pounds per foot. The posts shall be galvanized or painted with anti-corrosive paint. The posts shall be driven to the depths indicated or ordered and shall be located adjacent to the monument.

METHOD OF MEASUREMENT

621.04.01 Measurement. The quantity of reference monuments measured for payment will be the number of units complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

621.05.01 Payment. The accepted quantity of monuments measured as provided in subsection 621.04.01, "Measurement," will be paid for at the contract unit price bid per each, which price shall include metal marker posts, excavation, backfill, and disposing of any surplus material.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Reference Monuments	Each

SECTION 622

RAISED TRAFFIC BARS

DESCRIPTION

622.01.01 General. This work shall consist of furnishing and installing traffic separator bars, either precast or extruded in place, of the design and at locations shown on the plans or ordered by the Engineer.

MATERIALS

622.02.01 General. The traffic bars shall be constructed of material that will conform to the physical requirements listed below.

When required by the Engineer, traffic bars shall be sampled and tested and shall conform to the following requirements:

Flexure breaking load (air-cured conditions)	300 pounds min.
Compressive strength (air-cured conditions—7 days)	1,000 pounds min.
Abrasion loss (air-cured conditions)	10 percent max.
Abrasion loss (after soaking in water at room temperature for 24 hours)	10 percent max.
Absorption (24 hours in cold water)	10 percent max.

Extruded traffic bars shall be manufactured and placed by an automatic machine where Portland cement concrete is extruded under pressure through metering gates and a bar forming chamber. The aggregates shall be so graded and proportioned and thoroughly mixed in an approved mixer with such proportions of cement and water as will produce a homogeneous concrete mixture that the extruded traffic bars will conform to the test and design requirements of these specifications. In no case, however, shall the proportion of Portland cement in the mixture be less than six U.S. Standard (94 lb.) bags per cubic yard of concrete. There shall be no slump.

CONSTRUCTION

622.03.01 Installation. The area where the bars are to be placed shall be thoroughly cleaned of all dust, dirt and debris, and loose material.

The bars shall be set firmly or extruded in place on the finished surfacing with an adhesive in accordance with the directions of the manufacturer. Each precast bar shall fit the surface with reasonably uniform bearing and all excess adhesive material shall be squeezed out from under the bar.

Extruded-in-place bars shall be carefully trimmed and finished to the required shape and dimensions and thoroughly finished to present a neat and workmanlike job.

Precast bars shall be painted with masonry paint as specified in Section 714, "Paint."

Extruded bars shall be painted within thirty (30) minutes after placing with a mixture composed of white Portland cement and water mixed to a thick-cream consistency. After the white Portland cement application has set, the bars shall receive a uniform application of white pigmented liquid curing compound.

METHOD OF MEASUREMENT

622.04.01 Measurement. The quantity of raised traffic bars measured for payment will be the number of linear feet along the axis of each bar complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

622.05.01 Payment. The accepted quantity of raised traffic bars measured as provided in subsection 622.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Raised Traffic Bars	Linear Feet

SECTION 623

SIGNALS AND LIGHTING

DESCRIPTION

623.01.01 General. This work shall consist of furnishing and installing, modifying or removing one or more traffic signal systems, flashing beacon systems, highway lighting systems, sign illumination systems, electrical equipment on structures, partial installations for future systems, or combinations thereof, all as required by the plans, and as specified herein.

The locations of signals, beacons, standards, lighting fixtures, signs, controls, services, and appurtenances shown on the plans are approximate and the exact locations will be established by the Engineer in the field.

All systems shall be complete and in operation to the satisfaction of the Engineer at the time of acceptance of the contract.

623.01.02 Regulations and Code. All electrical equipment shall conform to the standards of the National Electrical Manufacturers Association (NEMA), the Underwriters' Laboratories Inc., (UL), or the Electronic Industries Association (EIA), wherever applicable. In addition to the requirements of the plans and specifications, all materials and workmanship shall conform to the requirements of the National Electrical Code, hereinafter referred to as the Code; Rules for Overhead Electrical Line Construction, the Public Service Commission; Standards of the American Society for Testing and Materials (ASTM); American Standards Association (ASA); and any local ordinances which may apply.

Wherever reference is made to the Code, or standards mentioned above, the reference shall be construed to mean the code, order, or standard that is in effect on the day the Notice to Contractors for the work is dated.

Wire sizes shall be based on American Wire Gage (AWG).

623.01.03 Equipment List and Drawings. Unless otherwise permitted in writing by the Engineer, the Contractor shall, within fifteen (15) days following approval of the contract, submit to the Engineer for review a list of equipment and materials which he proposes to install. The list shall be complete as to name of manufacturer, size, and identifying number of each item. The list shall be supplemented by such other data as may be required, including detailed scale drawings and wiring diagrams of any special equipment, and of any proposed minor deviation from the plans. All of the above data shall be submitted in duplicate for checking. Following checking, correction, and review, not less than three complete sets shall be submitted to the Engineer. The Department will not be liable for any material purchased, labor performed, or delay to the work prior to such review. Where electrical equipment will be constructed as detailed on the plans, the submission of detailed drawings and diagrams will not be required.

If ordered by the Engineer, the Contractor shall submit for review, sample articles of the material proposed for use.

The Contractor shall furnish three sets of traffic signal controller cabinet schematic wiring diagrams. The diagrams shall show the location of the installation and shall list all equipment installed in each cabinet. In addition, for each signal installation, the Contractor shall furnish an intersection sketch showing poles, detectors, and phasing. One copy of the controller cabinet diagram and the intersection and phase diagram as reviewed by the Engineer shall be permanently sealed in plastic and attached to the inside of the door of each controller cabinet.

A schematic wiring diagram of the controllers and auxiliary equipment shall be submitted at the time the controllers are delivered. This diagram shall show in detail all circuits and parts. Such parts shown thereon shall be identified by name or number and in such manner as to be readily interpreted.

Upon completion of the work, the Contractor shall submit three complete sets of "as-built" or corrected plans, and any data therefor, as required by the Engineer, showing in detail all construction changes, especially location

and depth of conduit and location of standards and pull boxes.

Manufacturer's warranties and guaranties furnished for materials used in the work shall be delivered to the Engineer. Instruction sheets and parts lists supplied with materials shall also be delivered to the Engineer.

623.01.04 Maintaining Existing and Temporary Electrical Systems. Existing electrical systems (traffic signal, highway and street lighting, flashing beacon, and sign illumination), or approved temporary replacement thereof, shall be kept in effective operation for the benefit of the traveling public during the progress of the work, except when shutdown is permitted to allow for alterations or final removal of the systems. The traffic signal system shutdowns shall be limited to periods during normal working hours, or as specified in the special provisions. Lighting system shutdowns shall not interfere with the regular lighting schedule, unless otherwise permitted by the Engineer. The Contractor shall notify the Engineer prior to performing any work on existing systems.

The local traffic enforcement agency shall be notified prior to any operational shutdown of a traffic signal system.

Where an existing system is being modified, work not shown on the plans or specified in the special provisions and which is considered by the Engineer as necessary to keep all or any part of the existing system in effective operation will be paid for as extra work as provided in subsection 104.03, "Extra Work."

State or local forces will continue operation and maintenance of existing electrical facilities. The State or local authorities will furnish electrical energy for operation and will repair or replace damaged facilities. Where damage is caused by the Contractor's operations, and repair is made by forces other than the Contractor's, the cost of repair or replacement shall be at the Contractor's expense and will be deducted from progress estimates due him.

The exact location of existing conduit runs and pull boxes shall be ascertained by the Contractor before using equipment that may damage such facilities or interfere with any system.

Where roadways are to remain open to traffic and existing lighting systems are to be modified, the lighting systems shall remain in operation and the final connection to the modified circuit shall be made so that the modified circuit will be in operation by nightfall of the same day.

Temporary electrical installations shall be kept in effective operation until the temporary installations are no longer required for the traveling public. Removal of temporary installations shall conform to the provisions in subsection 623.03.14(a), "Salvaging and Reinstalling or Stockpiling Electrical Equipment."

These provisions will not relieve the Contractor in any manner of his responsibility as provided in subsections 107.11, "Responsibility for Damage Claims" and 107.16, "Contractor's Responsibility for the Work and Materials."

623.01.05 Scheduling of Work. Work shall be so scheduled that each traffic signal system, highway lighting, and sign illumination system shall be completed and ready for operation prior to opening to traffic of the corresponding section of the roadway.

Traffic signal systems shall not be placed in operation for use by public traffic without the energizing of street lighting at the intersection to be controlled if street lighting exists or is being installed in conjunction with the traffic signals.

Traffic signal systems shall not be placed in operation until the roadways to be controlled are open to public traffic, unless otherwise directed by the Engineer.

Conductors shall not be pulled into conduit until pull boxes are set to grade, crushed rock sumps installed, grout placed around conduit, concrete bottom of pull boxes placed, and metallic conduit bonded.

In vehicular undercrossings, soffit lights shall be placed in operation as soon as practicable after falsework has been removed from the structure. Lighting for pedestrian structures shall be placed in operation prior to opening the structure to pedestrian traffic.

If the Engineer orders soffit lights or lighting for pedestrian structures placed in operation before permanent

power service is available, the cost of installing and removing temporary power service will be paid for as extra work as provided in subsection 104.03, "Extra Work."

623.01.06 Safety Precautions. Before starting work on existing series street lighting circuits, the Contractor shall obtain daily a safety circuit clearance from the serving utility. Bypass switch plugs must be pulled and "Men at Work" signs posted at bypass switch boxes before any work is done.

623.01.07 Definitions. The following definitions pertain only to traffic signal systems as referred to in this Section 623, "Signals and Lighting."

(a) Actuation. The operation of any type of detector.

(b) Clearance Interval. The length of time of display of the signal indication following the right of way interval.

(c) Detector for Traffic Actuation. A device by which vehicles or pedestrians are enabled to register their presence with a traffic signal controller.

1. Impact Detector. A detector installed in the roadway, capable of being actuated by the compression of air as a vehicle passes over a buried rubber tube.

2. Infra-Red Detector. A detector consisting of an infra-red light source and a photo-electric cell or cells capable of being operated by the reflection of infra-red light from a passing vehicle.

3. Magnetic Vehicle Detector. A detector installed in or near the roadway, cabable of being actuated by the magnetic disturbance caused by the passage of a vehicle.

4. Inductive Loop Detector. A detector installed in the roadway capable of being actuated by the change of inductance caused by a vehicle passing over or standing on the loop.

5. Pedestrian Detector. A detector, usually of the push button type, installed near the roadway and capable of being operated by hand.

6. Pressure-Sensitive Vehicle Detector. A detector installed in the roadway capable of being actuated by the pressure of a vehicle passing over its surface.

7. Radar Vehicle Detector. A detector installed over the roadway capable of being actuated by the passage of a vehicle through its field of emitted microwave energy.

8. Ultra-Sonic Detector. A detector consisting of an ultra-sonic (inaudible) sound wave source and suitable receiver, capable of being actuated by the reflection of sound from a vehicle passing through or standing within the zone of influence.

(d) Extendible Portion. That part of the green interval following the initial portion.

(e) Extension Limit. The maximum time for which actuations on any traffic phase may retain the right of way after actuation on another traffic phase, after the initial portion has been timed out.

(f) Flashing Feature. A device which, when operated, discontinues normal signal operation and causes the flashing of any pre-determined combination of signal lights.

(g) Initial Portion. The first part of the green interval which is timed-out or separately controlled by a traffic-actuated controller before the extendible portion of the interval takes effect.

(h) Interval. Any one of the several divisions of the time cycle during which signal indications do not change.

(i) Interval Sequence. The order of appearance of signal indications during successive intervals of a time cycle.

(j) Major Street. The roadway approach or approaches at an intersection normally carrying the major volume of vehicular traffic.

(k) Manual Operation. The operation of a signal controller by means of a hand-operated switch.

(l) Minimum Period. In semi-traffic-actuated controllers, the shortest time for which the right of way shall be given to the approaches not having detectors.

(m) Minor Street. The roadway approach or approaches at an intersection normally carrying the minor volume of vehicular traffic.

(n) Non-Parent Phase. A controller phase which is not modified by an auxiliary control unit.

(o) Parent Phase. A controller phase which is modified by an auxiliary control unit.

(p) Passage Period. The time allowed for a vehicle to

travel at a selected speed from the detector to the nearest point of conflicting traffic.

(q) Pre-Timed Controller. An automatic control device for supervising the operation of traffic control signals in accordance with a pre-timed cycle and divisions thereof.

(r) Recall Switch. A manual switch in an actuated controller which may cause the automatic return of the right of way to a street regardless of the absence of actuation on that street.

(s) Right of Way. The privilege of the immediate use of the highway.

(t) Signal Face. That part of a signal head provided for controlling traffic in a single direction and consisting of one or more lenses. Turning indications may be included in a signal face.

(u) Signal Head. An assembly containing one or more signal faces.

(v) Signal Indication. The illumination of a traffic signal lens or equivalent device, or of a combination of several lenses or equivalent devices at the same time.

(w) Time Cycle. The number of seconds required for one complete revolution of the timing dial or complete sequence of signal indications.

(x) Traffic-Actuated Controller. An electronic or electro-mechanical control device for supervising the operation of traffic control signals in accordance with the varying demands of traffic as registered with the controller by detectors or push buttons.

(y) Traffic Phase (Traffic Movement). A part of the cycle allocated to any traffic movement receiving the right of way or to any combination of traffic movements receiving the right of way simultaneously during one or more intervals.

(z) Unit Extension. The minimum time, during the extendible portion, for which the right of way must remain on any traffic phase following an actuation on that phase, but subject to the extension limit.

MATERIALS

623.02.01 General. Unless otherwise specified or indicated on the plans, all materials shall be new.

Where existing systems are to be modified, the existing materials shall be incorporated in the revised system, salvaged or abandoned as specified.

623.02.02 Foundations. Foundations for posts, standards, pedestals and controller bases shall be Class A or Class AA Portland cement concrete. Portland cement concrete shall conform to the provisions in Section 501, "Portland Cement Concrete."

The concrete for pressure-sensitive detector foundations shall contain not less than seven sacks of Portland cement per cubic yard, or six sacks of Portland cement per cubic yard using Type III cement conforming to ASTM Designation C150.

Aggregate for detector foundation concrete shall be three-fourths (¾) inch maximum size.

Anchor bolts shall conform to the specifications of ASTM Designation A307 and shall be provided with two nuts and two washers each. Anchor bolts, nuts, and washers shall be galvanized in accordance with the requirements of ASTM Designation A153.

623.02.03 Standards, Steel Pedestals, and Posts. Standards, steel pedestals, and posts shall conform to the provisions in Section 506, "Steel Structures," and to the following requirements:

(a) Type I Standards shall be used for post-top mounting of traffic signals with or without bracket mounted signals as shown on the plans.

(b) Type II and Type V Standards shall be used for mast arm mounting of traffic signals without luminaires and with or without bracket mounted traffic signals.

(c) Type III and Type VI Standards shall be used for mast arm mounting of both luminaires and traffic signals and with or without bracket mounted traffic signals.

(d) Type IV and Type VII Standards shall be used for mast arm mounting of luminaires with or without bracket mounted traffic signals.

Type I Standards and steel pedestals for controller cabinets shall be constructed of No. 11 or heavier U.S. standard gage steel or four (4) inch standard pipe or conduit, with the top designed for post-top slip-fitter.

Standard pipe shall conform to the specifications of ASTM Designations A53 or A120.

Types II, III, IV, V, VI, and VII Standards shall conform to the details shown on the plans and the following requirements:

(a) Standards shall be fabricated from (1) sheet steel conforming to the specifications of ASTM Designation A245, Grade C, or from (2) sheet steel of weldable grade. If alternative (2) is used, the steel, after fabrication, shall have a minimum yield of forty thousand (40,000) pounds per square inch.

(b) Standards with one mast arm shall be fabricated of not less than No. 10 U.S. standard gage steel, except that when material conforming to alternative (2) above is used, the gage shall not be less than No. 11 U.S. standard gage steel.

(c) Standards may be fabricated of full length sheets or shorter sections. Each section shall be fabricated from not more than two pieces of sheet steel. Where two pieces are used, the longitudinal welded seams shall be directly opposite one another. When the sections are butt-welded together, the welded seams on adjacent sections shall be placed to form continuous straight seams from base to top of standard.

(d) Standards shall be straight, with a permissive variation not to exceed one (1) inch measured at the midpoint of a 28.5, 30, or 35 foot standard and not to exceed three-fourths (¾) inch measured at the midpoint of an 18, 20, or 25 foot standard.

(e) The butt-welded transverse joints shall be strengthened by inserting a metal sleeve at each joint. The sleeve shall be No. 10 U.S. standard gage steel and made from steel having the same chemical composition as the steel in the standard. The metal sleeve shall have a minimum length of one (1) inch. The sleeve shall be centered at the

joint and have the same taper as the standard with the outside of the sleeve in full contact with the inside of the standard throughout the sleeve length and circumference.

(f) All welds shall be continuous.

(g) The weld metal at the transverse joint shall extend to the sleeve, making the sleeve an integral part of the joint.

(h) All longitudinal welds shall be performed by the submerged arc process.

(i) All exposed welds, except fillet welds, shall be ground flush with the base metal.

(j) All exposed edges of the plates which make up the base assembly shall be finished smooth and all exposed corners of such plates shall be neatly rounded to one-eighth (⅛) inch radius, unless otherwise shown on the plans. Shafts shall be provided with slip-fitter shaft caps.

Handholes in the base of standards shall conform to the details shown on the plans.

Mast arms for Types II, III, and IV standards shall be fabricated from standard pipe, reamed, free from burrs and without intermediate splices or couplings, curved to the dimensions shown on the plans and shall be provided with raintight connections to shafts. Standard pipe shall conform to the specifications of ASTM Designations A53 or A120.

Mast arms for Types V, VI, and VII standards shall be fabricated from material as specified for standards and shall conform to the dimensions shown on the plans.

Tie rods for mast arms for Types II, III, and IV standards shall be manufactured of structural steel and pipe as shown on the plans. Structural steel shall conform to the specifications of ASTM Designation A36. Tie rods shall be provided with two nuts and two lock washers at each end. Tie rods shall be installed with no kinks or bends.

Workmanship and finish shall be equal to the best general practice of metal fabrication shops.

Push button posts and guard posts shall be pipe conforming to the specifications of ASTM Designations A53 or A120.

Anchor bolts and nuts required for relocating existing standards shall be furnished by the Contractor.

New standards, posts, and other ferrous materials shall be galvanized as provided in subsection 623.02.10, "Galvanizing."

623.02.04 Conduit. Conduit and fittings to be installed underground shall be (a) rigid metal type manufactured of mild steel, wrought iron, or a silicon-bronze alloy containing at least 1.25 percent silicon and shall conform to UL Publication UL6 for Rigid Metallic Conduit or (b) rigid nonmetallic type conforming to the requirements of the UL proposed Standard for Rigid Plastic Conduit (Publication UL543).

Where rigid metallic conduit is used underground, it shall be either tarred and wrapped or shall be spirally wrapped with a corrosion protective polyvinyl chloride or polyethylene pressure sensitive tape, applied with a suitable primer. The wrap shall have a nominal thickness of 20 mils, consisting of either one layer of 20 mil tape or two separate layers of 10 mil tape. A single wrap of 10 mil tape with a half lap will not be acceptable.

Tapes shall be Chase & Sons "Chasekote" No. 755, Plicoflex No. 340–25, Polyken No. 920, Johns-Mansville "Trantex" No. V–20, Minnesota Mining "Scotchrap" No. 51, Warco No. D–1015, Plymouth Rubber Company No. 200, Seamless Rubber Co. No. 659, or equal, and applied as recommended by the manufacturer.

A certificate of compliance conforming to the provisions in subsection 106.05, "Certificates of Compliance" shall be submitted by the manufacturer with all rigid metallic conduit and all rigid nonmetallic conduit.

623.02.05 Pull Boxes. Pull boxes and extensions shall be precast reinforced concrete boxes of the sizes and details shown on the plans. Reinforcement shall conform to that used in the standard product of the manufacturer.

For signal systems, or combined signal and low voltage lighting systems, reinforced concrete covers shall be inscribed "Traffic Signals" and for lighting systems reinforced

concrete covers shall be inscribed "Street Lighting" ("High Voltage," where applicable). Covers shall be secured with two three-eighths (⅜) inch brass hold-down bolts with brass washers and nuts. Nuts shall be recessed below the surface of cover.

Where pull boxes are to be placed in areas subject to traffic loads, a steel or cast iron cover shall be used in lieu of the concrete cover. Such pull boxes shall be installed on a suitable concrete footing to withstand traffic loads. Cover shall be inscribed as specified above for reinforced concrete covers.

All nonmetallic pull boxes with metal covers shall have the covers effectively grounded with a three (3) foot copper braid attached to the metallic conduit or to a ground rod inside the pull box.

Where a ballast or transformer is to be placed in a pull box, the box shall be provided with recesses for a hanger.

623.02.06 Expansion Fittings. Expansion fittings, as detailed on the structure plans, shall be installed where the conduit crosses an expansion joint in the structure. Each expansion fitting shall be provided with a bonding jumper of No. 6 AWG, copper wire, or equal.

Expansion-deflection fittings shall consist of a bolted neoprene sleeve with a bonding jumper passing through a separate waterproof compartment and two silicon bronze couplings. Fittings shall permit a three-fourths (¾) inch expansion and contraction and a three-fourths (¾) inch deflection without deformation.

623.02.07 Conductors. Unless otherwise specified, conductors shall consist of solid or stranded copper of the gage shown on the plans. Copper wire shall conform to the specifications of ASTM Designations B3 and B8. Insulation shall be TW Grade polyvinyl chloride compound conforming to the specifications of ASTM Designations D2219 and D2220, for conductors No. 14 AWG and larger and TF Grade for conductors No. 16 AWG and smaller.

For all electrical conductors, insulation shall be of solid color, or of basic colors with a permanent colored stripe, to

identify conductors as detailed in the table following this subsection 623.02.07, unless otherwise specified.

Traffic signal conductors and multiple circuit lighting conductors shall be rated for 600 volt operation. The insulation (except as noted in the following paragraph) shall be four sixty-fourths ($\frac{4}{64}$) inch thick for Nos. 14 to 9 AWG, inclusive, and five sixty-fourths ($\frac{5}{64}$) inch for No. 8 AWG, or larger.

Conductors in the controller cabinets, other than conductors terminating in conductor plugs, shall have two sixty-fourths ($\frac{2}{64}$) inch minimum thickness of insulation. Conductors terminating in conductor plugs shall have 1½/64 inch minimum thickness of insulation.

Conductors in traffic actuated controller cabinets between service terminals and the "AC+" terminals on external light relays (including connections to the police panel switches), the signal light neutral, and all conductors in the highway lighting circuit within the controller cabinet shall be No. 10 AWG, or larger. All other conductors in the signal light circuits shall be No. 14 AWG.

All conductors in controller cabinets subject to flexing during opening and closing of the cabinet door or on removal of equipment from the cabinet shall be stranded. Conductors No. 14 AWG through No. 10 AWG, inclusive, shall be 19 strand and conductors No. 16 AWG shall be 26 strand.

Conductors for series highway lighting shall be No. 8 AWG, solid or stranded copper with ten sixty-fourths ($\frac{10}{64}$) inch minimum thickness of insulation and rated for 5,000 volt operation.

Homogeneous, as referred to in ASTM Designations D2219 and D2220, shall mean pore sizes are less than 0.010 inch in diameter, except that pores of any size will not be acceptable if the pores impair the protective value of the insulation.

Series lighting conductors shall be tested in conformance with the requirements set forth in the Insulated Power Cable Engineer's Association "General Specifications for Wire and Cable With Rubber and Rubber-Like Insulation," Section 7.7, Specifications for "Series Lighting Wire

and Cable with Thermoplastic Synthetic Insulation, 3,000 and 5,000 Volt Service."

A certificate of compliance conforming to the provisions in subsection 106.05, "Certificates of Compliance," shall be submitted by the manufacturer with all 5,000 volt, series, lighting conductors.

Connection cable for ultrasonic detectors shall be two conductor, neoprene jacketed, heavy duty, shielded microphone cable conforming to the following specifications:

Description	Specification
Conductors	18 AWG (41 x 34 stranded)
Insulation thickness	0.022 inch ± 10 percent
Jacket thickness	0.038 inch ± 20 percent
Nominal outer diameter	0.295 inch ± 10 percent
Percent shield coverage	80 to 100

Conductors for wiring wall luminaires shall be stranded copper, insulated with silicon rubber and asbestos braid for use at temperatures up to one hundred twenty-five (125) degrees Centigrade. Wire size shall be as shown on the plans.

Overhead lighting conductors shall be No. 8 AWG, or larger, medium hard drawn copper with weatherproof covering.

CONDUCTOR TABLE

Circuit	Signal Phase or Function	Identification — Insulation Colors — Base	Stripe (Note 1)	Band Symbols (Note 6)	(Size AWG)
Vehicle Signals	A	Red, Yellow, Green	Black	Band only special (A^1) and overlap (A + C^1) phases. Simple phases such as A, B, C, or D do not require banding.	14
	B	Red, Yellow, Green	White		14
	C	Red, Yellow, Green	None		14
	D	Red, Yellow, Green	Orange		14
Pedestrian Signals	Aw	Red, Green	Black	Aw (Note 2)	14
	Bw	Red, Green	White	Bw (Note 2)	14
	Cw	Red, Green	None	Cw (Note 2)	14
	Dw	Red, Green	Orange	Dw (Note 2)	14
Pedestrian Push Buttons	Aw	Blue	Black	P–A (Note 2)	14 or Larger
	Bw	Blue	White	P–B (Note 2)	
	Cw	Blue	None	P–C (Note 2)	
	Dw	Blue	Orange	P–D (Note 2)	
Detectors (Note 10)	A	Blue	Black	D-(Location No.)-A (Note 2)	12
	B	Blue	White	D-(Location No.)-B	12
	C	Blue	None	D-(Location No.)-C	12
	D	Blue	Orange	D-(Location No.)-D	12
Traffic Signal Controller	Ungrounded between Service Switch & Controller	Black	None	CON	10 or Larger
Series Lighting (Note 9)	Loop or Service	Black	None	No band required	8
Lighting	Ballast to Luminaire	Black	None	No band required	10
Multiple Highway Lighting (Note 9)	Ungrounded—Line 1	Black	None	ML 1	10 or Larger
	Ungrounded—Line 2	Red	None	ML 2	

CONDUCTOR TABLE—*Continued*

		IDENTIFICATION			
		INSULATION COLORS			
Circuit	*Signal Phase or Funcion*	*Base*	*Stripe (Note 1)*	*Band Symbols (Note 6)*	*Size (AWG)*
Lighting Control	Ungrounded to P.E.C. unit	Black	None	C 1	14
	Switching leg from P.E.C. unit or SM transformer	Red	None	C 2	14
Multiple Service	Ungrounded—Line 1 (Signals)	Black	None	No band required except per Note 5	8 or Larger
	Ungrounded—Line 2 (Lighting)	Red	None		
Sign Lighting (Note 8)	Ungrounded between transformer or Service Switch and Ballasts	Black	None	SL	12 or Larger
Flashing Beacons (Note 7)	Ungrounded between Flasher and beacons	Red or Yellow	None	F-Location No. See Note 3	14 or Larger
Neutral & Common (Note 4)	Detectors & Pedestrian Push Buttons	White	Black	No band required	12
	Signals & Multiple Lighting	White	None	No band required	10 or Larger
	Flashing Beacons & Sign Lighting	White	None	No band required	12
	Lighting Control	White	None	C–3	14
	Multiple Service	White	None	No band required	8 or Larger
Interconnect	Common	White	None	I	14
	Flash	Orange	None	I–F	14
	Dial 2	Orange	None	I–D2	14
	Dial 3	Orange	None	I–D3	14
	Offset	Orange	None	I–O	14
Railroad Pre-emption		Black	None	R	14
Spares		Black	None	No band required	14

NOTES

1. On overlaps, insulation is striped for first phase in designation, for example, a phase ($A + C_1$) conductor is striped as for phase A.
2. Stamp for overlap and special phases as required.
3. Flashing beacons having separate service do not require banding.
4. A single No. 12 common shall be used for detectors and pedestrian push buttons.
5. "S" if circuit is switched on line side of service equipment by utility.
6. Band conductors in each pull box and near ends of termination points. On signal light circuits, a single band shall be placed around 2 or 3 ungrounded conductors comprising a phase.
7. Ungrounded conductors between service switch and flasher mechanism shall be black and stamped as indicated in this column.
8. Conductors between ballasts and sign lighting lamps shall be No. 16 and color shall correspond to that of the ballast leads.
9. Both conductors between mercury-vapor ballast or isolating transformer and luminaire shall be black No. 10 without banding.
10. Use only for pressure sensitive detectors or for wiring between transceivers or amplifiers and detector terminals and controller cabinets. For circuits between transducers or associated amplifiers, use 2 No. 18 AWG shielded cables with black insulation, no stripe, and banded for detector.

623.02.08 Wood Poles. Wood poles for service or temporary installation shall be ASA Class 5, or larger, Douglas Fir or Southern Yellow Pine.

Poles shall not have more than one hundred eighty (180) degrees twist in grain over the full length. Sweep shall be no more than four (4) inches. Top of poles shall be beveled. Poles shall be placed in the ground to a depth of at least six (6) feet. The lengths of poles shall be twenty-five (25) feet for service poles and thirty-five (35) feet for other poles, unless otherwise specified.

After each wood pole is set in the ground, the space around the pole shall be backfilled with selected earth or sand, free of rocks and other deleterious material, placed in layers approximately 0.33 foot thick. Each layer shall be moistened and thoroughly compacted.

Mast arms and tie rods for wood pole installations shall conform to the provisions in subsection 623.02.03, "Standards, Steel Pedestals, and Posts," and to the details shown on the plans. Each mast arm shall be provided with an insulated wire inlet and wood pile mounting brackets for mast arm and tie rod crossarm.

Mast arms for luminaires shall be mounted to provide a mounting height of thirty (30) feet. Mast arms for traffic signals, flashing beacons, and overhead detectors shall provide a minimum vertical clearance of seventeen (17) feet from bottom of equipment to the pavement.

Wood poles, not to be painted, shall be pressure treated after fabrication as provided in Section 615, "Preservative Treatment for Timber."

623.02.09 Sign Switches. Each sign illumination installation shall be provided with a disconnect switch mounted on the sign standard or structure, as shown on the plans. Where the sign lighting is served from a series lighting system through a series-multiple transformer or from a multiple service, each sign structure shall have a single pole, two-wire, 120 volt, AC switch with 15 ampere fuse, approved as service equipment.

Enclosure for the sign switch shall be NEMA Type 3R hot-dip galvanized in accordance with the provisions in subsection 623.02.10, "Galvanizing" and shall be provided

with top hinged cover, hasp for sealing cover, and provisions for locking the handle in the "On" and "Off" positions. Padlocks will be furnished by others.

623.02.10 Galvanizing. Standards, poles, posts, cabinets, and bypass switch boxes of ferrous materials shall be galvanized in accordance with the provisions in Section 715, "Galvanizing," except that cabinets and cutout boxes may be constructed of material galvanized prior to fabrication, in which case, all cut or damaged edges shall be painted with at least two coats of zinc oxide-zinc dust paint conforming to Federal Specification MIL–P–15145. Other types of protective coating shall be approved by the Engineer prior to installation.

Iron or steel pipe standards and mast arms shall be hot-dip galvanized after fabrication in conformance with the specifications of ASTM Designation A120.

Tie rods, nuts, washers, clamps, and other miscellaneous ferrous parts shall be hot-dip galvanized after fabrication in accordance with the provisions in Section 715, "Galvanizing."

Not less than ten (10) inches of the upper end of the anchor bolts and all nuts and washers shall be galvanized in accordance with the provisions in Section 715, "Galvanizing."

After galvanizing, the bolt threads shall accept galvanized standard nuts without requiring tools or causing removal of protective coatings.

Galvanizing of existing materials in an electrical installation will not be required.

623.02.11 Signal Systems. (a) Controllers. A controller shall consist of a complete electrical mechanism for controlling the operations of traffic control signals, including the timing mechanism and all necessary auxiliary equipment, mounted in a cabinet.

1. Interval Sequence. The color sequence of signal indications shall be green, yellow, red. During any interval there shall be no visual flicker of signal indications.

2. Flashing Operations. All controller cabinets shall be equipped for flashing operation of signal lights.

Flashing operations, when required by railroad pre-emption, flashing control, or other causes, shall be set for flashing yellow lights on the main street or highway and for flashing red on the cross street or streets or left turn lanes, unless otherwise specified in the contract documents or directed by the Engineer.

3. Railroad Pre-emption. Railroad pre-emption equipment shall be constructed and wired so as to transfer control of the signals from the controller to the pre-emption timing unit. Pre-emption shall cause a "yellow" indication to be displayed prior to "flashing red" indication if actuated during "green" or "flashing yellow" interval, unless otherwise specified in the contract documents. Installation of the railroad pre-emption equipment shall not alter the internal wiring of the controller normally furnished by the manufacturer. Pedestrian "WALK—DON'T WALK" signals shall be placed on "DON'T WALK" during railroad pre-emption and shall be turned off during the protection interval.

The railroad pre-emptor shall operate as follows:

Immediately after actuation by the normally open or closed track circuit, as shown on the plans, the pre-emptor shall stop controller timing and start the pre-emptor timing unit. When the timing unit reaches its first position, the pre-emptor shall simultaneously (a) Transfer traffic signal head circuits to the pre-emptor timing unit and (b) Determine and select, by sensing relays, the proper signal indications for the first pre-emption interval, as shown on the plans.

The pre-emptor shall then time out the initial, track clearance, and yellow intervals and come to rest on the protection interval. During this time, and in order for the controller to resume operation on the green interval shown on the plans, the pre-emptor shall reset the controller to that yellow interval which normally precedes the indicated green interval. The pre-emptor shall then place calls on all phases of traffic actuated controllers and on pedestrian interval timers, if any.

When the track circuit is released, the pre-emptor shall begin timing the termination yellow interval and

shall release controller timing. The controller yellow shall time out just before the pre-emptor completes its timing and transfers signal head circuits back to the controller.

Once pre-emption is initiated, holding circuits shall run the pre-emptor through its full cycle even though the track circuit is interrupted prematurely.

The timing unit shall consist of the plug connected dial unit and contact drum assembly of a pre-timed traffic controller. The dial unit shall have machined slots for timing keys. Contact drum assembly shall provide twelve positions and all necessary contacts and wiring for not less than twelve signal light circuits. Timer gears and dial keys shall provide cycle lengths of 20, 25, 30, 35, 40, and 45 seconds.

The dial and drum units shall automatically synchronize at any time if the dial or drum is moved off home position or if they become out of step in operation. Signal circuit transfer and controller timing shall not be affected during re-synchronizing.

The pre-emptor flasher shall conform to the requirements in this subsection, 623.02.11(a)6.c., "Flasher and Flasher Relay," and shall operate continuously.

If pre-emptor requires a cabinet in addition to the controller cabinet, connecting conduit between cabinets shall not be less than three (3) inches in diameter. No equipment shall be mounted less than one (1) inch above floor or cabinet.

Each pre-emptor shall be furnished with a wiring diagram. Physical layout of relays in cabinet shall correspond with that on diagram. Relays performing similar functions shall be grouped together.

The Contractor shall submit preliminary schematics and a detailed description of components of pre-emptor equipment and receive approval prior to assembly of the equipment.

4. Operating Voltage. All equipment, except pedestrian push buttons and pressure detectors, shall be designed to operate from a 120 volt, 60 cycle, AC supply. Operation shall be satisfactory at voltages from 110 to 130.

The voltage for pedestrian push buttons and pressure detectors shall not exceed 50 volts.

5. Radio Interference Suppressors. Each traffic controller, flasher and other current interrupting device shall be equipped with a suitable radio interference suppressor installed at the input power point. Interference suppressors shall be of a design which will minimize interference in both broadcast and aircraft frequencies, and shall provide minimum attenuation of 50 decibels over a frequency range of 200 kilocycles to 75 megacycles when used in connection with normal installations. The interference suppressor shall be hermetically sealed in a substantial metal case filled with a suitable insulating compound. Terminals shall be nickel plated, 10–24 brass studs of sufficient external length to provide space for connecting two No. 8 AWG conductors and shall be so mounted that the terminals cannot be turned in the case. Ungrounded terminals shall be properly insulated from each other, and shall maintain a surface leakage distance of not less than one-fourth (¼) inch between any exposed current conductor and any other metallic part, with an insulation factor of 100–200 megohms dependent on external circuit conditions. Suppressors shall be designed for operation on 25 amperes, 125 volts, 60 cycles, single-wire circuits, and shall meet standards of the UL and the EIA.

6. Traffic Actuated Controllers. The types of traffic actuated controllers, cabinets and auxiliary equipment will be designated in the contract documents.

Time spans and actuation limits given for various functions are minimum and may be expanded.

The adjusted vehicle clearance interval for all types of traffic actuated controllers shall remain constant regardless of the reason for phase termination.

a. Controllers. Types of traffic actuated controllers are as follows:

Type 1 Controller. Type 1 controller shall be two-phase, full traffic actuated, traffic control device capable of transferring traffic indication from one phase to the other as the movement of traffic demands.

In the absence of detector actuation, or closed recall

switch, the right of way shall remain on the traffic phase upon which the last actuation occurred.

The actuation of a detector in the lane or lanes having the right of way during the extendible portion of that traffic phase shall cause the retention of right of way by that traffic phase for one unit extension from the time of actuation.

The actuation of any detector on a traffic phase not having the right of way shall cause the transfer of the right of way to that traffic phase immediately following the expiration of one unit extension during which there was no actuation on the other traffic phase.

The transfer of the right of way for any traffic movement shall take place only after a proper clearance interval which is adjustable from two (2) to eight (8) seconds. The adjusted interval shall remain constant regardless of the reason for phase termination.

The minimum green interval shall consist of an initial portion and one unit extension. The initial portion shall be adjustable between ten (10) and thirty (30) seconds. The unit extension shall be adjustable from two (2) to twelve (12) seconds.

Successive detector actuations spaced less than one unit extension shall not retain the right of way for more than the extension limit.

The timing of the extension limit shall commence with the first actuation on the traffic phase not having the right of way, provided that the initial portion has expired.

An actuation during the clearance period for a traffic phase shall cause the right of way to return to that phase immediately following the expiration of one unit extension during which there was no actuation on the other traffic phase.

When the traffic demand on any phase is continuous and spaced less than a unit extension, the extension limit shall limit the resetting of the unit extension and terminate the extension of right of way on that phase. The extension limit shall be adjustable between ten (10) and sixty (60) seconds.

When the right of way is transferred by the operation

of the extension limit, the traffic phase losing the right of way shall again receive it without further actuation immediately following the expiration of one unit extension during which there is no actuation on the other traffic phase, or the expiration of the extension limit on the other traffic phase.

A recall switch shall be provided for each traffic phase. When closed, the recall switch shall cause the automatic return of the right of way to the desired traffic phase or to both traffic phases, alternately, in the event both recall switches are closed.

Type 2 Controller. Type 2 controller shall be a three-phase, full traffic actuated, traffic control device with functions similar to the Type 1 controller except that three phases shall be provided, and timing of the vehicle extension limit shall commence with the first actuation on either traffic phase not having the right of way.

The Type 2 controller shall be equipped with provision for skipping any phase when there is no call for that particular phase.

The controller shall be equipped so that it may be coordinated with other controllers or supervised by a master system.

Type 3 Controller. Type 3 controller shall be two-phase, full traffic actuated, traffic control device capable of transferring traffic control indication from one phase to the other as the movement of traffic demands and shall be capable of increasing and decreasing the various time intervals due to variations in volume of moving traffic and of waiting traffic.

The controller operations shall include, but shall not be limited to the following functions:

In the absence of detector actuation, the right of way shall remain on the traffic phase upon which the last actuation occurred.

When the transfer of the right of way occurs on any traffic phase, the minimum green interval shall consist of a minimum initial portion, adjustable between five (5) and sixty (60) seconds.

Continued actuations on the traffic phase not having

the right of way beyond a predetermined number of actuations shall cause the initial portion next shown for that traffic phase to be increased. This added initial portion shall be in relation to the number of added actuations, adjustable between five and thirty-five, and the increase in the time per actuation shall be adjustable between zero (0) and two (2) seconds.

In light and intermittent traffic, an actuation on a traffic phase having the right of way shall cause the retention of the right of way by that traffic phase for one passage period from the time of actuation. Passage period shall be adjustable between five (5) and fifteen (15) seconds.

Should the transfer of the right of way from one traffic phase to another take place before the passage period has expired, the right of way shall be returned to that traffic phase without further actuation.

The transfer of the right of way from any traffic phase shall take place only after a clearance interval adjustable from two (2) to eight (8) seconds.

Successive actuations on any traffic phase shall not retain the right of way on that traffic phase for more than the extension limit. The extension limit shall be adjustable between ten (10) and ninety (90) seconds.

The timing of the extension limit shall commence with an actuation or other registration of traffic demand for right of way on the traffic phase not having the right of way, provided the minimum initial portion and the added portion have expired.

An actuation during the clearance period for a traffic phase shall cause the right of way to return to that phase without further actuations.

The length of the unit extension on any traffic phase shall be variable within predetermined limits and shall be established by the features described as follows:

**The frequency of actuations on any traffic phase having the right of way shall determine the unit extension on that traffic phase.

Actuation on any traffic phase not having the right of way shall reduce the unit extension on the traffic phase

having the right of way in proportion to the time elapsing after that actuation.

**Successive actuations on any traffic phase not having the right of way shall decrease the unit extension on the traffic phase having the right of way in proportion to the number of actuations.

**Actuations on a traffic phase having the right of way shall by the operation of the carryover when the right of way is transferred to another traffic phase, reduce the unit extension of the latter traffic phase in anticipation of the expected arrival of a platoon of vehicles on the first traffic phase.

A recall switch shall be provided for each traffic phase which, when closed, shall cause the automatic return of the right of way to the desired traffic phase or to both traffic phases, alternately.

Pilot lights shall be provided to indicate the position of the controller at all times with regard to operating intervals on each traffic phase and also to indicate which of the several effects is responsible for termination of right of way. A switch shall be provided to energize the pilot lights only when needed.

Type 4 Controller. Type 4 controller shall be a three-phase, full traffic actuated, traffic control device with functions similar to the Type 3 controller, except as follows:

Three phases shall be provided.

The right of way shall not be given to any street in the absence of actuation thereon.

Paragraphs marked ** under "Type 3 controller" do not apply to the Type 4 controller.

The Type 4 controller shall be equipped with provision for skipping any phase when there is no call for that particular phase.

Type 5 Controller. Type 5 controller shall be a two-phase, semi-traffic actuated, control device which shall, in response to calls from the minor street, transfer the right of way to the minor street.

In the absence of actuation of any detector, the right

of way shall return to and remain on the approaches not provided with detectors.

The transfer of the right of way from any traffic movement shall take place only after a clearance interval which is adjustable from two (2) to eight (8) seconds.

Following the transfer of the right of way to the approaches not provided with detectors, a minimum period which is adjustable from thirteen (13) to eighty (80) seconds shall be timed before transfer of the right of way to the approaches having detectors.

The actuation of any detector shall cause the right of way to be transferred to that approach at the expiration of a minimum period, in accordance with the interval sequence provided.

The minimum green interval on approaches having detectors shall consist of an initial portion and one unit extension. The initial portion shall be adjustable from two (2) to twelve (12) seconds. The unit extension shall be adjustable from two (2) to twelve (12) seconds.

The actuation of any detector during the extendible portion shall cause the right of way to remain on that traffic phase for an additional unit extension to be timed from the moment of detector actuation.

If there is no detector actuation during the extendible portion, the right of way shall be transferred to the approaches without detectors.

Successive detector actuations spaced less than a unit extension shall not retain the right of way for more than the extension limits. The extension limit shall be adjustable from thirteen (13) to sixty (60) seconds.

When the right of way is transferred by the operation of the extension limit, the right of way shall be returned to the approaches with detectors after the expiration of a minimum period.

The controller shall be so equipped that it may be coordinated with other controllers or supervised by a master system.

Auxiliary Movement Controller. Auxiliary movement controller shall be a traffic actuated auxiliary traffic control device capable of modifying all or a portion of an

actuated controller traffic phase for the purpose of permitting an auxiliary traffic phase.

In the absence of auxiliary movement detector actuation, the controller traffic phase shall not be modified.

The minimum green interval shall consist of an initial portion and one unit extension. The initial portion shall be adjustable from two (2) to fifteen (15) seconds. The unit extension shall be adjustable from two (2) to twelve (12) seconds.

The actuation of an auxiliary movement detector during the extendible portion shall cause retention of the right of way for one unit extension from the time of actuation.

Successive detector actuations spaced less than a unit extension shall not retain the right of way for more than the extension limit. The extension limit shall be adjustable from ten (10) to sixty (60) seconds.

The timing of the extension limit shall commence immediately following expiration of the initial portion, except that the extension limit may be allowed to function during other intervals of the controller for secondary timing purposes.

Upon the expiration of one unit extension during which there was no actuation on the auxiliary movement detector, right of way shall be returned to the parent phase.

The transfer of the right of way shall take place only after a proper clearance interval which is adjustable from two (2) to eight (8) seconds.

An actuation during the clearance period shall cause the right of way to return to the auxiliary traffic phase following the answering of traffic demand on the parent, non-parent and other phases of the intersection controller.

When the right of way is transferred by the operation of the extension limit, the right of way shall return to the auxiliary traffic phase following the answering of traffic demand on the parent, non-parent and other phases of the intersection controller.

Timing of the controller parent phase shall either begin with auxiliary movement timing or shall be stopped until the auxiliary movement timing has terminated, as required to provide system operation in accordance with

the phase diagrams shown on the plans and as specified in the special provisions. In those systems where the auxiliary movement timing can extend beyond the parent phase, timing shall be stopped on the green interval of the following phase and shall be released when the auxiliary movement terminates.

Parent and non-parent calls shall be placed in such a manner that modification of the controller traffic phase will take place at the first instant of parent phase green.

A recall switch shall be provided for each auxiliary movement controller.

Phase Skip Unit. Phase skip unit shall be an auxiliary control unit for supervising the functioning of auxiliary movement controllers when used in conjunction with one phase (parent phase) of a two-phase traffic actuated controller.

With the two-phase controller resting in the parent phase, and in the absence of acutations on the non-parent phase, an auxiliary actuation shall cause the phase skip unit to provide means for returning the controller to the initial portion of parent phase during which the minor movement phases normally occur without the necessity of the signal system passing through the non-parent phase.

The return to the auxiliary movements will be governed by the normal operating features of the controller and shall be accomplished, without change in any signal indications, through the various timing intervals to the beginning of the parent green interval. A normal length parent yellow shall be displayed prior to the beginning of the green indication for left turn traffic.

An actuation on the non-parent phase shall result in normal operation of the controller and sequence of phases.

b. Mechanism for Traffic Actuated Controllers. Construction of controllers shall be equal to that of first-class electrical instruments. Each variable shall be individually adjustable over its entire range by indicating type knobs, mounted on the timing panel of the controller. Changing the timing of one interval shall not change the timing of any other interval.

The controller shall be so designed that temperature variation between zero (0) degrees Fahrenheit and plus

one hundred sixty (160) degrees Fahrenheit shall not change the timing intervals by more than five (5) percent.

All contact points which make, break, or carry electrical current shall be of fine silver, silver-alloy, or superior alternative material, and shall be capable of making, breaking, and carrying a current of one hundred fifty (150) percent of maximum demand load of that particular circuit without causing electrical or mechanical trouble through one million operations.

All bearings, except approved sealed bearings, or moving parts shall be of such design that lubrication at one (1) year intervals shall be sufficient to assure continuous operation.

The complete controller, and each auxiliary unit as specified, shall be assembled, wired, and housed in separate metal cases. All circuits of each unit shall terminate in a multiple contact connector. Conductors shall be attached to all pins of the connector and cabled. Conductors of the cable, except spares, shall be fitted with terminals to match the terminal block and shall have identifying bands. Ends of spare conductors shall be taped.

Connectors on all equipment cables shall be provided with strain relief clamps.

In addition to actuation by vehicles, provisions shall be made in the mechanism for each phase for actuation or indirect actuation by means of pedestrian push buttons or railroad pre-emption, or both, without altering the controller mechanism.

c. Auxiliary Equipment for Traffic Actuated Controllers. The following auxiliary equipment shall be furnished and installed in each cabinet for traffic actuated controllers:

Flasher and Flasher Relay. Flasher shall be a motor driven, or an electronic device, producing between fifty and sixty flashes per minute, and shall provide equal on and off intervals. The flasher mechanism shall be mounted on a plug-in base with a plug-in mounting. The flasher relay shall energize the flasher and transfer signal light circuits from controller to flasher and shall permit flashing yellow lights on the main street or highway and flashing red on the cross-street or streets and left turn lanes and

shall be similar in construction to external light relays specified for use with traffic actuated controllers.

Flashing mechanism shall be independent of the controller and shall remain in operation upon shutdown of the controller or removal of the controller from the cabinet.

External Light Relays for Controllers. Relays shall be installed in the controller cabinet, external to the controller.

External light relays shall be wired so that all opposing and conflicting traffic movements shall have a red indication prior to the display of green indication on the phase which is to receive the right of way.

The relay assembly shall be one of the following types:

For two-phase controllers—two double-pole, double-throw relays.

For three-phase controllers—six single-pole, double-contact, double-throw relays.

Relays for special control devices and external light relays for pedestrian signals shall have double-pole, double-throw contacts.

Relays shall be designed for continuous duty. Relays shall operate during ambient temperatures from zero (0) degrees Fahrenheit to plus one hundred sixty (160) degrees Fahrenheit. Each relay shall be mounted on a plug-in base with plug-in mounting. Banana spring type plugs and jacks shall be used.

Contact points shall be of fine silver, silver-alloy, or superior alternative materials.

Contact points and contact arms shall be capable of carrying a current of 20 amperes per contact at 120 volts, 60 cycles, AC.

Coils shall have a power consumption of 10 volt-amperes or less. Coils shall be designed for continuous duty and shall be insulated for 120 volt operation.

A leakage resistor, which will permit a small amount of current to pass through the relay coil if the contacts should remain closed after the coil circuit is opened, shall be installed with external light relay to overcome residual magnetism effects.

External light relays shall conform to the requirements of the following tests:

Load Test. Relays shall show no failure while making, carrying, and breaking a 20 ampere, 120 volt, AC, traffic signal lamp load through 10,000 cycles at the rate of 100 cycles per minute. The cycle shall be 50 percent on and 50 percent off.

Overload Test. Relay shall be electrically and mechanically operative after a momentary current of 100 amperes, 120 volts is applied to each set of closed contacts at least five times with a minimum of two (2) minutes between applications of current.

Relay shall not break down or flashover while carrying a load of 30 amperes, 120 volts for at least 50 cycles at the rate of five cycles per minute. Cycle shall be 50 percent on and 50 percent off.

Dielectric Strength Test. Relays shall withstand a potential of 1,500 volts at 60 cycles per second between insulated parts and between current carrying parts and grounded or non-current carrying parts.

d. Special Auxiliary Equipment. Special auxiliary equipment shall be furnished and installed when shown on the plans or when required to perform specified functions, some of which are as follows:

Overlap Relays. Relays shall be installed to provide overlap shown in phase diagrams. Overlap relays shall be the same types as specified for external light relays in this subsection 623.02.11(a)6.c., "External Light Relays for Controllers."

Special Timing. Interval timers shall be installed for special timing.

Pedestrian Interval Timers. Interval timers shall be installed for pedestrian actuation, which may be operated in conjunction with the time extension traffic actuated controllers to provide a minimum green interval of suitable length for pedestrian movement and pedestrian clearance.

The pedestrian interval timer assembly shall provide the following sequence of operation:

Steady green "WALK" interval.

Steady red "DON'T WALK" clearance interval.

Steady red "DON'T WALK" interval.

This equipment shall be designed to provide the following functional operations as related to one of the phases of the controller. The equipment shall be so designed that two or more pedestrian interval timers may be used for pedestrian movements associated with other phases of controller, if desired.

In the absence of actuation of the pedestrian push buttons, the traffic actuated controller shall respond to vehicle actuation in accordance with its dial settings and without regard to the pedestrian interval timer.

Actuation of the pedestrian push buttons with the controller showing red to the traffic phase associated with the pedestrian movement, shall place a call for right of way on said phase.

When the right of way is next given to the selected phase, the pedestrian interval timer shall time a pedestrian interval and a pedestrian clearance interval of selected durations. The length of these intervals shall be readily adjustable.

Signal circuits shall be provided for the display of "WALK" indication during the pedestrian interval and for "DON'T WALK" indication during the pedestrian clearance interval. In addition to the display of the "DON'T WALK" indication during the pedestrian clearance interval, the "DON'T WALK" indication shall be maintained at all times except when the pedestrian "WALK" indication is displayed.

Means shall be provided whereby the extension functions or minimum green functions of the traffic actuated controller may be operated, in such a manner as to guarantee the display of the green vehicular signal to the selected phase for a period equal to the sum of the pedestrian interval plus pedestrian clearance interval. Actuation of pedestrian push buttons during any part of right of way interval associated with the pedestrian movement or clearance shall not change the length of said intervals.

Actuation of a pedestrian push button during the pedestrian clearance interval or at any other time while the pedestrian "DON'T WALK" indication is being displayed, shall register the presence of said pedestrian. This actuation

shall be remembered so that the pedestrian "WALK" indication will be accorded at the next opportunity in the normal cycle of the traffic controller.

In the event of a registered pedestrian actuation on a selected phase with no demand for pedestrian or vehicular right of way on an opposing phase or phases of the vehicle actuated controller, the pedestrian interval timer shall be capable of recycling and providing pedestrian and pedestrian clearance intervals with associated pedestrian signal indications.

In the event of a pedestrian requirement for right of way on a phase having the green light but with demand for the right of way on an opposing phase of the vehicle actuated controller, the pedestrian interval timer shall remember said pedestrian actuation and call for the necessary pedestrian intervals after the vehicle actuated controller has served the opposing demands.

The pedestrian interval timer shall be enclosed in a metal case. It shall be equipped with suitably tagged leads to allow the addition of the equipment to existing traffic actuated controllers. It shall be so designed that all connections from the housing terminals to the pedestrian interval timer can be made by inserting a multi-terminal plug into the plug receptacle incorporated in the unit.

The pedestrian interval timer shall be designed for operation on 115 volts, 60 cycles and shall have power consumption not to exceed 10 watts. The pedestrian push button circuits shall operate on a voltage not in excess of 18.

In lieu of a separate pedestrian interval timer, pedestrian interval timing may be included as an integral part of the traffic signal controller.

Railroad Pre-emption Relays. Railroad pre-emption relays shall be of the same types specified for external light relays in this subsection 623.02.11(a)6.c., "External Light Relays for Controllers," and shall perform the operations provided in this subsection 623.02.11(a)3., "Railroad Pre-emption."

Directional Detector Relays. A directional detector relay unit shall be installed for each phase using directional detectors.

Calling Detector Relays. A calling detector relay shall be installed for each phase using a calling detector to eliminate a call from the calling detector to the controller during its associated green interval.

Telephone Relays. Each telephone relay for interconnection shall be single-pole, single-throw, with normally open contacts rated at 1½ amperes, 120 volts, and with coil rated at 10,000 ohms, DC, and current sensitive to energize at a minimum of two milliamperes. The relay shall be sealed with a dustproof enclosure having a plug-in base for a standard octal socket.

Two ½ ampere fuses shall be installed in the telephone circuit.

A four by four and one-half by three inch (4″ x 4½″-x 3″) sheet metal closure with a fiber board barrier separating the AC and DC circuits, shall house the components specified in this subsection within the controller cabinet.

Test Switches. Test switches shall be installed in the controller cabinet to place calls on each phase. Test switches shall conform to the provisions in this subsection 623.02.11(b)6., "Pedestrian Push Buttons," and shall be mounted on a single readily accessible bracket, and shall be identified with labels.

e. Traffic Actuated Controller Housing. Each traffic actuated controller shall be housed in a weatherproof aluminum, sheet metal, or other approved metal cabinet or cabinets, as shown on the plans, of sufficient size to contain the controller, all auxiliary equipment, and the following fittings:

Substantial shelves or brackets to support controller and auxiliary equipment.

Control panel assembly where shown on the plans consisting of:

Controller switch which shall be wired to energize the controller timing circuits while the signal lights are off or are being operated by flasher. Switches shall be labeled and rated for load current.

Three-wire, 15-ampere, NEMA standard plug receptacle with grounding contact.

Plug fuse receptacle.

Two or more insulated terminal blocks for terminating

field conductors. Each block shall be provided with twelve poles with screw type terminals to accommodate at least five wires, size No. 14 AWG, and shall be capable of securely holding one No. 18 AWG. The terminal block shall be a barrier type with shorting bars in each of the twelve positions and with integral type marking strips.

The cabinet shall have a main door, which shall be equipped with a keyed tumbler lock, and an auxiliary door equipped with lock for police key. Two keys shall be furnished for each lock. Each police key shall have a shaft at least one and three-fourths (1¾) inches in length. Door hinge pins shall be made of stainless steel.

The cabinet shall be installed with the back toward the nearest line of traffic.

A panel shall be provided behind the auxiliary door and shall contain a main power switch and a switch to control the change from automatic to flashing operations and vice versa. In the "flashing" position, the controller shall be de-energized. Switches shall be labeled and rated for load current. Switch terminals on rear on main cabinet door shall be insulated so that no live parts are exposed.

Each controller cabinet door which is twenty-two (22) inches, or larger in width or six (6) square feet, or larger in area shall be provided with a stop to limit door opening to both ninety (90) and one hundred eighty (180) degrees, plus or minus ten (10) degees. The stop shall be provided with a catch which will operate when the door reaches the extreme open position and will hold the door open securely until released.

One screened, raintight vent, one and one-half (1½) inches in diameter, or larger, shall be installed in the top of the controller cabinet and eight screened, raintight vent holes one-half (½) inch in diameter, or larger shall be provided in the lower back side or bottom of the controller cabinet.

Where the cabinet is mounted on a concrete pedestal foundation, a one (1) inch drain hole or pipe, with screen, shall be placed in the foundation, connecting to the cabinet and emptying above the ground line.

Each controller cabinet with inside volume less than seven (7) cubic feet shall be equipped with an electric fan

with ball or roller bearings and a capacity of at least fifty (50) cubic feet per minute.

Each controller cabinet with inside volume seven (7) cubic feet or larger shall be equipped with an electric fan with ball or roller bearings and a capacity of at least one hundred (100) cubic feet per minute.

The fan shall be mounted in a raintight housing attached to the top of the controller cabinet.

The fan shall be thermostatically controlled and shall turn on at a temperature inside the controller cabinet of one hundred twenty (120) degrees Fahrenheit and off at one hundred (100) degrees Fahrenheit. The fan motor shall be protected with a ¼ ampere fuse.

The fan and cabinet vent holes shall be located with respect to each other so as to direct the bulk of the air flow over the controller case or through the ventilating holes of the controller case where such holes exist.

Conductors and cables in controller cabinet shall be as specified in subsection 623.02.07, "Conductors."

When the controller supplied by the Contractor has terminal plugs different from those on the same type controller now in general use by the Department of Highways, the Contractor shall provide a harness which will permit interchangeability of the controller. The cabinet shall be provided with sufficient space to permit interchanging of controllers.

Receptacles for relays, timers, and flashers shall be of the type now in general use by the Department of Highways.

7. Pre-Timed Controllers. Pre-timed controllers shall be the expandable type designed to permit the installation of plug-connected dial units without additional wiring or modification of the controller. Controllers shall be one-dial, two-dial, or three-dial. The types of pre-timed controllers, number of dials, cabinets, and auxiliary equipment shall be as designated on the plans or specified in the special provisions.

a. Controllers. Pre-timed controllers shall be of the following types:

Type 25 Controllers. Type 25 controllers shall be the future interconnected type and shall be capable of

being operated as future units in an interconnected, master controlled flexible progressive system by the addition of easily installed auxiliary attachments.

Type 26 Controllers. Type 26 controllers shall be the interconnected type; shall be capable of being operated as units in an interconnected, master controlled flexible progressive system; and shall have three resets per dial, unless otherwise specified in the special provisions.

Type 27 Controllers. Type 27 controllers shall be the combined master and intersection interconnected type and shall be similar to Type 26 controllers, except that the Type 27 shall be equipped with master reset supervision, dial change, offset selection and flashing operation of the intersection controllers.

b. Operations. All pre-timed controllers shall be capable of being operated by manual control; as a pre-timed controller of the independent, isolated type; and as a synchronous-motor-driven coordinated type, for progressive timing without interconnecting circuits.

c. Mechanism for Pre-Timed Controllers. Mechanism for pre-timed controllers shall be constructed as a complete, self-contained, readily interchangeable unit arranged to swing out for inspection while in operation. All parts shall be readily accessible.

All circuits of each unit shall be terminated in a multiple-contact connector. Connection between the connector and the panel or field terminal board shall be by means of a flexible cable. Panel or field terminal board end of the conductors shall be fitted with proper terminals. Each field terminal shall be identified.

d. Motor and Dial. Controller motor shall be of the self-starting, synchronous type, and shall have ample torque for the requirements of the controller operation.

All intervals in each phase shall be readily adjustable by a suitable dial on the face of the controller. Intervals shall be adjusted in steps not to exceed one (1) percent of the total cycle by means of self-retained timing keys.

Each dial unit shall consist of motor, dial with slots for timing keys, contact block, motor switch, and connector for plug-in mounting of the entire dial unit assembly. Design of the dial unit shall allow gear changing without

tools or with simple tools. The cycle length of the gear used shall be indicated on the face of the dial unit when the gear mesh is correct.

A suitable dust cover shall be provided for the timing mechanism. Dial key settings shall be visible without the necessity of removing the cover.

e. Signal Contact Mechanism. All parts of the contact mechanism for signal lights, including contacts and contact supports, shall operate one million times without mechanical wear that impairs normal operation.

All signal light contact points shall be of fine silver, silver alloy, or superior alternative material not less than five-sixteenths ($\frac{5}{16}$) inch in diameter; shall be of not less than 10 ampere capacity, capable of operating one million times without excessive burning or pitting; and shall be easily removed and replaced.

Cam or drum assembly shall provide not less than twelve intervals, all necessary contacts and provisions for not less than a total of fourteen signal light contacts. Wiring shall be complete from terminal strip to each contact position.

f. Auxiliary Equipment. Each pre-timed controller shall be equipped with switches properly marked and a complete set of gears for each dial (fifty (50) to one hundred twenty (120) seconds, inclusive, in ten (10) second steps) unless otherwise specified.

Controls. Wiring shall provide local control of the following functions:

Transfer from automatic to manual operation and vice versa.

*Transfer from normal operation to flashing and vice versa.

**Transfer from one dial to another.

Turn-off signal lights only without shutting down controller mechanism.

Shutdown timer mechanism.

Switches. Combined master and intersection controllers shall have additional switches properly marked for Functions * and ** above for the interconnected system. Switch for local control of Function ** is not required at the master.

Combined master and intersection controllers shall also have provisions for time switch or program device control of Functions * and ** above for the interconnected system.

Interconnected controllers shall have relays and wiring for remote control of Functions * and ** above.

Future interconnected controllers shall have provisions for local time switch control of Functions * and ** above.

Flashers. Each pre-timed controller shall be wired and furnished with a plug-in-mounted flasher and provisions for jack-mounted relays to permit flashing yellow lights on the main street or highway and flashing red lights on the cross street or streets, conforming to the provisions of this subsection 623.02.11(a)6.c., "Flasher and Flasher Relay."

Plug-in-mounted flasher and jack-mounted relays for flasher shall be independent of the controller and shall remain in operation upon the shut down of the controller or removal of the controller from the cabinet.

Manual Control. Each pre-timed controller shall be provided with labeled terminals for a hand switch and cord set for manual operation of signals.

Mounting Panel. A readily accessible mounting panel shall be furnished in each pre-timed controller cabinet, with adequate provisions for terminating all field circuits and for mounting fuses and relays. Each power and direct wire interconnect circuit, except neutrals, shall be fused.

g. Special Auxiliary Equipment. The following special equipment shall be furnished and installed when specified in the special provisions or shown on the plans:

Time Switches. Time switches to control system or local flash, dial change, or other specified functions. Time switch shall be synchronous motor driven; shall be equipped with ten (10) hour spring wound reserve carryover; shall be equipped with an omitting device; and shall provide for at least three openings and three closings per twenty-four (24) hour period. Mechanical and electrical

characteristics shall be equal to those specified in this subsection 623.02.11(a)7.c., "Mechanism for Pre-Timed Controllers."

Railroad Pre-emption. Railroad pre-emption relays, when required, shall perform the operations provided in this subsection 623.02.11(a)3., "Railroad Pre-emption."

h. Pedestrian Signal Sequence. The controller shall provide the following sequence of operations for pedestrian signals:

Steady green "WALK" interval
Steady red "DON'T WALK" clearance interval
Steady red "DON'T WALK" interval

i. Pre-Timed Controller Housing. Each pre-timed controller shall be enclosed in a weatherproof metal cabinet of the type regularly supplied by the manufacturer, unless otherwise specified.

The cabinet shall be fitted with a master-keyed police lock and shall be mounted on a pedestal or pole as shown on the plans. Two keys with shanks at least one and three-fourths (1¾) inches long, shall be furnished for each controller.

The cabinet shall be fitted with a slip-fitter attachment to permit post-top mounting as shown on the plans, unless it is to be bracket mounted.

One screened, raintight vent, one and one-half (1½) inches in diameter, or larger, shall be installed in the top of the controller cabinet and eight screened, raintight vent holes one-half (½) inch in diameter, or larger, shall be provided in the lower backside or bottom of the controller cabinet.

Each controller cabinet door which is twenty-two (22) inches or larger, in width or six (6) square feet or larger in area shall be provided with a stop to limit door opening to ninety (90) and one hundred eighty (180) degrees plus or minus ten (10) degrees. The stop shall be provided with a catch which will operate when the door reaches the extreme open position and will hold the door open securely until released.

623.02.11(b) Traffic Signals and Appurtenances.

1. Signal Faces. Each signal face shall be of the

adjustable, colored light, vertical type with the number and type of sections as specified herein and as shown on the plans; shall provide an indication in one direction only; shall be adjustable through three hundred sixty (360) degrees about a vertical axis; and shall be mounted at the location and in the manner shown on the plans. Unless otherwise shown on the plans, all vehicle signal faces shall contain three sections arranged: red—top, yellow—center, green—bottom. Pedestrian signals shall be the "WALK—DON'T WALK" gas tube type and shall be installed where shown on the plans.

All new vehicular signal faces installed at any one intersection shall be of the same make and type.

All new pedestrian signal faces installed at any one intersection shall be of the same make and type.

Vehicle and pedestrian signal mountings shall be oriented so as to provide maximum horizontal clearance to the adjacent roadway.

a. Optical Units. Each optical unit shall consist of a lens, a reflector, a lampholder, and a clear traffic signal lamp, visible to the traffic to be controlled.

Lenses shall be of the color indicated, circular in shape, with a visible diameter of approximately eight (8) inches or twelve (12) inches. Each lens shall be true to color, of best quality glass, free from imperfections, of high luminous transmission, and shall conform to the latest standards of ASA.

A twelve (12) inch red section shall be provided for each mast arm mounted signal face. The yellow and green sections for each mast arm mounted signal face shall be eight (8) inches, unless otherwise shown on the plans.

A twelve (12) inch section with crosshatched lens shall be provided for all green arrow signal indications. Configuration of the arrows shall conform to the dimensions shown on the plans.

Each reflector shall consist of a one-piece, best quality, clear glass, parabolic reflector, free from bubbles and striae. The convex surface shall be silvered by chemical deposition to such thickness that the lighted filament of a 150 watt incandescent lamp will not be visible through the silver layer. The silvered surface shall be protected by an

additional coating of electrolitically deposited copper. The opening in the back of the reflector for the lampholder shall be so constructed that there will be no dark spots cast on the lens.

The lampholder shall be of weatherproof, molded construction, immune to the operating temperatures in the unit, of the vibration-proof type, and shall be substantially supported. The lampholder shall be provided with two wires of sufficient length to be connected to the terminal block specified. The reflector and lampholder assembly shall position the lamp filament at the focal center of the reflector.

Each reflector, lens, and hood shall be designed in such a manner as to reduce sun-phantom to a minimum.

Lamps for the eight (8) inch units shall be 650 lumen minimum initial output, 120 volt, 6,000 hour rated life, clear, traffic signal lamps.

Lamps for the twelve (12) inch units shall be 1,900 lumen minimum initial output, 120 volt, 6,000 hour rated life, clear, traffic signal lamps.

b. Housing. The signal face housing, or case, shall consist of an assembly of separate interchangeable sections, expansible type for vertical mounting without tie rods, substantially secured together in a watertight manner to form a unit. Each section shall house an individual optical unit.

Each section shall be complete with a one-piece, hinged door mounting for the lens and other parts of the optical system, watertight gaskets, and a simple doorlocking device. The optical system shall be so mounted that the various parts may be swung open for ready access or removal. The sections shall be interchangeable and so constructed that sections can be removed or added. There shall be a round opening in the top and bottom of each head to receive one and one-half (1½) inch supporting pipe frame. All parts of the housing, including the door and end plates, shall be of die cast aluminum conforming to the specifications of ASTM Designation B85, and all parts shall be clean, smooth, and free from flaws, cracks, blow holes, or other imperfections.

All exposed bolts, screws, hinge pins, and doorlocking

devices shall be stainless steel. All interior screws and fittings shall be stainless steel or approved non-ferrous, corrosion-resistant material.

All gaskets, including door, lens, and reflector gaskets, but not including lampholder gaskets, shall be of neoprene. Lampholder gaskets shall be of material not affected by heat.

All lampholders shall be so wired that a white wire will be connected to the shell of the lampholder and a black or colored wire to the bottom or end terminal of the lampholder. These wires shall, in turn, be connected to the terminal block mounted inside at the back of the housing. The terminal block shall have sufficient screw type terminals so as to terminate all field wires and lamp wires independently, with separate screws. The terminals to which field wires are attached shall be permanently identified or wiring shall be color coded to facilitate field work.

Each lens shall be provided with a removable hood, 0.030 inch thick, of sheet aluminum of the full circle type completely closed, except at the ends. Hoods for eight (8) inch section shall be eight (8) inches minimum length and for twelve (12) inch section shall be eleven (11) inches minimum length unless otherwise shown on the plans. Hoods and housing shall be painted as provided in subsection 623.03.12, "Painting."

2. Directional Louvers. Where shown on the plans, louvers shall be furnished and installed in signal hoods. Directional louvers shall be so constructed as to have a snug fit in the signal hoods. The outside cylinder shall be constructed of No. 22 U.S. gage sheet steel and the vanes shall be constructed of No. 27 U.S. gage sheet steel or the cylinder and vanes shall be constructed of 3003 H14 aluminum alloy of similar construction. Thickness dimensions and arrangements of vanes shall be as shown on the plans.

Sheet steel louvers shall be galvanized as provided in subsection 623.02.10, "Galvanizing."

Louvers shall be painted as specified in subsection 623.03.12, "Painting."

3. Back Plates. Where shown on the plans, back plates shall be furnished and attached to the signal faces to

provide a dark background for signal indications. Back plates shall be constructed of 3003 H14 aluminum alloy sheet 0.051 inch minimum thickness, and of the dimensions shown on the plans. Back plates shall be painted as specified in subsection 623.03.12, "Painting."

4. Signal Head Mounting. Bracket mounted signal heads, as shown on the plans, shall be supported by mounting brackets consisting of watertight assemblies of one and one-half (1½) inch standard galvanized steel pipe and malleable iron or brass pipe fittings. All members shall be either plumb or level, symmetrically arranged, and securely assembled. Construction shall be such that all conductors are concealed within the assembly.

The dimensions of mounting brackets between the axis through the center of the terminal compartment, or slip-fitter, shall not exceed eleven (11) inches, except where required to provide proper signal head alignment or directed by the Engineer.

At each signal location, unless otherwise shown on the plans, a terminal compartment shall be constructed into the mounting brackets. Each compartment shall be fitted with a terminal block containing twelve poles, each with two screw type terminals. Each terminal shall accommodate at least five No. 14 AWG conductors. A raintight cover shall be provided, giving ready access to the terminal block. Terminal compartment shall be bronze or aluminum of sufficient strength to remain intact in event the pole is knocked down. Slip-fitters, where used without integral terminal compartment, shall be of cast-iron, bronze, or aluminum.

For post-top mounting of bracket mounted signals, the terminal compartment shall be cast with an integral slip-fitter. Slip-fitter shall fit over a four (4) inch standard pipe for four and one-half (4½) inch outside diameter end of tapered standard. Each slip-fitter shall be provided with two rows of steel set screws, with three screws in each row to secure the assembly in plumb position. Set screws shall be cadmium plated.

Where signal heads are side mounted on poles, the terminal compartment shall be designed to bolt securely to the pole.

Signal heads shall be equipped with positive brass lock rings and fittings designed to prevent heads from turning due to external forces. Lock ring and connecting fittings shall have serrated contacts.

Signal head assembly for suspension from mast arm shall be equipped with a slip-fitter as shown on the plans.

Signal heads shall not be installed at any intersection until all other signal equipment, including the controller, is in place and ready for operation at that intersection, except that the signal heads may be mounted if the faces are not directed toward traffic or if the faces are covered.

Mounting brackets and fittings shall be painted as specified in subsection 623.03.12, "Painting."

5. Detectors. Detectors shall be used for actuating traffic actuated controllers and shall be the pressure-sensitive type, unless otherwise specified in the contract documents.

a. Pressure-Sensitive Vehicle Detectors. Pressure-sensitive vehicle detectors shall be of the nondirectional types, and of the lengths shown on the plans.

Nondirectional detectors, in combination with control equipment, shall be capable of actuation by a vehicle crossing the detector at any speed up to sixty-five (65) miles per hour under normal conditions.

Directional detectors, in combination with control equipment, shall be capable of actuation by a vehicle crossing the detector in one direction at any speed up to thirty-five (35) miles per hour under normal conditions, but not when crossing the detector in the opposite direction.

A directional detector relay unit shall be furnished and installed in the controller cabinet for each phase having a directional detector.

The detector contact unit shall be mounted in a steel frame provided with a splice box. The splice box shall be provided with a weatherproof door or cap. The splice box shall be placed in such a position that the splice box door or cap can be opened without disturbing the pavement. All necessary anchoring and installation accessories shall be supplied with each detector. Provision for draining the splice box shall be provided.

The detector frame shall be so constructed that contact units of either the directional or nondirectional type can be inserted and removed without disturbing the installation in the pavement. Detector contact unit mounting pan may be either removable or nonremovable.

Nonremovable contact unit mounting pans shall be provided with inspection holes as specified in subsection 623.03.02, "Foundations."

The contact units of detectors shall be of one piece construction and shall be so designed that no metal screws or bolts shall be exposed to traffic wear. The surfaces of contact units, which are exposed to traffic, shall consist of rubber, seven-eighths (⅞) inch thick. The rubber shall be specially compounded for the duty which it is to perform, and shall be securely vulcanized to the metal base plate of the contact units. Bolts which hold the contact unit in the frame shall be stainless steel, shall be provided with a medium spring steel lock washer, and shall not extend above the pavement surface. The rubber surface exposed to traffic shall be not less than eight (8) inches in width and the length shall be the specified length of the detector. The surface of the contact unit shall not be higher than one-eighth (⅛) inch above the rim of the frame and in no case shall the surface be lower than the rim. If the surface of the contact unit is low, the contact unit shall be raised using one-piece, galvanized, sheet metal shims with dimensions the same as the bottom surface of the contact unit.

The electrical contact area of the contact unit shall be waterproof and there shall be a waterproof splice between the contact area and the conductors to the signal controller.

Detectors shall be so constructed that they will close a normally open electric circuit and will make an electrical contact whenever any motor vehicle wheel passes over the detector.

Pavement and base material removed for the installation of the detector frame and foundation shall be disposed of as provided in subsection 623.03.03, "Excavating and Backfilling." Cuts in existing pavement shall be made as provided in subsection 623.03.04, "Removing and Replacing Improvements."

Concrete foundation for the detector shall be installed as provided in subsection 623.03.02, "Foundations."

Bolts for removable pan type detectors shall be cadmium plated steel, five-eighths (⅝) inch diameter, and shall thread into a stainless steel nut welded to the detector frame.

Anti-seize compound shall be used on screw threads and shall conform to the requirements of Federal Specification MIL–A–907.

b. Inductive Loop Detector. Inductive loop detectors shall be furnished and installed at the locations shown on the plans and as specified in this subsection.

Each inductive loop detector shall consist of a loop or loops of electrical conductors, a sensor unit, a sensor unit relay, and a power source.

The loop shall be installed in slots cut in the pavement and shall be oriented in the traffic lane as shown on the plans. The size and type of conductor and method of installation shall conform to the detector manufacturer's recommendations.

The sensor unit shall be an electronic device, capable of operating one or more detector loops and shall be mounted in a metal case. Case volume shall not exceed five hundred fifty (550) cubic inches and maximum dimensions shall be ten (10) inches. The case with the sensor unit shall be mounted (1) in a raintight, galvanized, sheet metal, or equivalent cabinet which shall be mounted on a standard, as shown on the plans, or (2) in the controller cabinet.

Power supply units capable of furnishing the requirements for all sensor units shall be housed in the traffic signal controller cabinet.

When the power supply is included in the same case with one to four sensor units, the case volume shall not exceed seven hundred twenty (720) cubic inches and the maximum dimension shall be not more than twelve (12) inches.

The detector shall operate on the principle that a vehicle crossing over or standing over the loop will cause a change in inductance which shall be detected by the sensor unit which shall operate the sensor unit relay. The

sensor unit relay shall operate the detector relay in the traffic signal controller.

The detector shall provide vehicular actuations under the following conditions:

It shall be responsive only to a vehicle passing over or standing over any portion of the area within the loop.

It shall be responsive to vehicles passing over at speeds up to eighty (80) miles per hour.

It shall be responsive to a vehicle standing over it. The detector relay shall be de-energized immediately after a vehicle leaves the loop areas.

For detectors installed in left turn lanes, the detector circuit shall be designed to keep the detector relay closed for at least ten (10) minutes when a vehicle stands in the loop area.

It shall operate normally under any range of weather, temperatures, humidity, and climatic conditions, including rain and snow.

The operation of the entire detector shall not be affected by normal line transients.

c. Ultrasonic Detectors. Each ultrasonic vehicle detector shall be a presence indicator, which, in combination with a transceiver unit, can detect vehicles within its operating zone, whether the vehicles are stationary or moving at any speed up to eighty (80) miles per hour. Detection shall depend upon the vehicle interrupting a beam of ultrasonic (inaudible) sound waves. The detector shall be equipped with a two (2) inch slip-fitter.

The sensing unit of the detector shall be side-fire type, unless otherwise specified, and shall include no vacuum tubes. It shall have an aluminum cast housing and shall contain two identical transducers. The transducers shall transform electrical energy to sound energy and vice versa.

The detector shall be designed to indicate the presence of a vehicle at a distance of from eight (8) to forty (40) feet. In the event of a power failure or transceiver unit failure, a continuous call shall be registered.

The electronic elements, consisting of a transmitter, a receiver, a power supply, and an indicating relay, shall

be mounted on a chassis in the signal controller cabinet. The chassis shall be plug connected to the external circuits. A terminal strip shall be provided for the external connections on the chassis.

Two cables shall be installed without splices between sensing unit and the terminal strip on the electronic element chassis.

Cable shield shall be grounded at chassis.

Field wiring connections and adjustments of the ultrasonic detectors and transceiver unit shall be as directed by the Engineer.

6. Pedestrian Push Buttons. Where shown on the plans, pedestrian push buttons of substantial tamper-proof construction shall be furnished and installed.

The assembly shall be weatherproof and so constructed that it will be impossible to receive any electrical shock under any weather conditions.

The pedestrian push button switch shall be a phenolic enclosed precision snap-acting type, switching unit, single-pole, double-throw, with screw type terminals, rated 15 amperes at 125 volts, AC, and shall have the following characteristics:

Switching unit shall have a steel plunger actuator and shall be provided with U-frame to permit recessed mounting in push button housing.

Switch shall have an operating force of nine (9) to thirteen (13) ounces and a minimum release force of four (4) ounces.

Pretravel shall be $\frac{1}{64}$ inch maximum.

Overtravel shall be $\frac{7}{32}$ inch minimum.

Differential travel shall be 0.0004 to 0.002 inch.

Where a pedestrian push button is attached to a pole, the housing shall be shaped to fit the curvature of the pole and secured to provide a rigid installation. Saddles shall be provided to make a neat fit when required.

Where a pedestrian push button is to be mounted on top of a two and one-half (2½) inch diameter post, the housing shall be provided with a slip-fitter fitting and screws for securing rigidly to the post.

Push button and sign shall be installed on the crosswalk side of the pole.

Arrows on push button signs shall point in the same direction as the corresponding crosswalk.

7. Pedestrian Signals. Gas tube type pedestrian signals shall conform to the following:

a. Messages. Messages shall be green "WALK" and red "DON'T WALK." The letters shall be a minimum of four and one-half (4½) inches in height. The words may be formed by either Type A or Type B signals.

Type A signals, consisting of gas tubes bent in the form of letters shall conform to the following:

In the upper compartment, red tubing shall form the word "DON'T" and the rear half of the tubing shall be coated with black blot-out paint.

In the lower compartment, clear red tubing shall be placed in front of green tubing, both forming the word "WALK." The rear half of the green tubing only shall be coated with gray blot-out paint.

The inside surfaces of the upper and lower compartments and also the inside faces of the hoods shall be finished with two coats of flat black enamel.

Tubing shall be nine (9) millimeter minimum diameter for red letters and eight (8) millimeter minimum diameter for green letters.

Tubing for green letters shall be coated on the inside with fluorescent material.

The front of the gas tubes section shall be covered with a single piece of three-sixteenths ($^3/_{16}$) inch minimum thickness clear acrylic plastic or crystal glass. Acrylic plastic shall be weather, craze, and heat resistant.

Type B signals consisting of internally illuminated letters formed on hammered glass by painting the glass, except for the area forming the letters, shall conform to the following:

The front panel on which the letters are formed shall be three sixteenths ($^3/_{16}$) inch minimum thickness hammered glass or hammered wire glass.

The letters shall have a stroke width of five-eighths (⅝) inch.

The "DON'T" tubing shall consist of eight lengths of eight (8) millimeter clear red tubing extending horizontally across the "DON'T" compartment and spaced so as to provide even illumination of the letters.

The "WALK" tubing shall be similar to the "DON'T" tubing, except that the "WALK" tubing shall consist of eight lengths of red tubing placed in front of eight lengths of green tubing. The green tubing shall be coated inside with fluorescent material producing a green color.

b. Housing. The housing shall be made of cast aluminum of 3003 H14 sheet aluminum alloy with finish on both sides, and shall be one-eighth (⅛) inch thick minimum at the points of support.

The housing for pedestrian signals shall be dustproof, weatherproof, and corrosion resistant and shall provide for easy access to, and replacement of, all components.

The housing shall be suitable for either post-top or bracket mounting.

c. Hoods. The hood shall be of material similar to the housing. The top of the hood shall extend a minimum length of seven (7) inches. The front shall be normal to the top.

A full divider strip shall be provided between the "DON'T" and the "WALK" indications.

d. Transformers. Transformers shall be of the proper size for the length of tubing and shall carry the label of UL or Electrical Testing Laboratories.

A separate transformer shall be provided for each of the "DON'T WALK" and the "WALK" indications.

The red words "DON'T" and "WALK" shall operate from a single transformer.

Transformers shall have a power factor of ninety (90) percent and shall provide 27 milliamperes minimum current.

e. Conductors. High-voltage wiring between the gas tubes and the secondary side of the transformer shall be made with Gas Tube Sign and Oil Burner Ignition Cable, Type GTO–15 labeled by UL.

Other conductors shall be No. 14 AWG, or larger, with two sixty-fourths ($\frac{2}{64}$) inch minimum type TW insulation.

f. Switch. A double-pole, single-throw disconnect switch shall be mounted within the signal housing and connected so as to de-energize the transformer primary circuit.

g. Relays. All relays for operation of the "WALK—DON'T WALK" signals shall be placed in the controller cabinet.

h. Fasteners. All the machine screws, studs, and washers shall be either plated brass, stainless steel, or other corrosion-resistant material.

i. Gaskets. Gaskets shall be provided as required to make the unit raintight and dusttight.

Gaskets shall conform to the provisions in ASTM Designation D1056, Grade SBE 42L.

j. Tube Mounting. Capped ends of gas tubing shall be mounted in approved pyrex glass electrode housings. Tubing shall be replaceable without opening the rear compartment or disconnecting any wires.

k. Terminal Block. A terminal block as specified in "Housing," shall be mounted in the unit for field wiring.

l. Finish. The outside of the housing and hood shall be painted in accordance with the provisions in subsection 623.03.12, "Painting."

623.02.11(c) Lighting and Appurtenances.

1. Mercury Vapor Luminaires. Mercury vapor luminaires shall be horizontal burning type. Unless otherwise specified, light distribution shall be ASA Type III.

Luminaires shall be provided for slip-fitter end mounting on two (2) inch mast arms.

Glassware shall be the refractor type with inner or outer prisms.

The refractor shall be mounted in a door frame assembly which shall be hinged to the luminaire at the house side and fastened at the street side by means of an automatic type latch.

The refractor and door frame assembly shall be forced upward at the street side by spring pressure, against the gasket seat, when in the closed and latched position.

All gaskets shall be composed of a material capable of withstanding the temperature involved and they shall be securely held in place.

All parts of the luminaire shall be manufactured from corrosion-resistant materials.

Unless otherwise specified in the contract documents, lamps shall be hard glass type, 400 watt, mercury vapor, ASA Type H33–ICD, with a minimum average rated life of 16,000 hours.

Unless otherwise specified in the contract documents, all luminaires shall have an integral ballast as provided in subsection 623.02.11(c)12., "Ballasts."

Glare shields shall be provided on mercury vapor luminaires only when specified on the plans.

2. Fluorescent Luminaires and Accessories. Fluorescent luminaires shall be as shown on the plans.

The luminaires and accessories shall conform to the following:

a. Reflector Housing. The reflector housing shall be fabricated with 0.050 inch thick, 3003 H14 aluminum alloy or shall be fabricated with other approved material.

All aluminum surfaces of the reflector housing shall be treated in accordance with Federal Specification MIL–C–5541 modified, after which two coats of approved white baked-on enamel shall be applied to the exterior surfaces of the housing.

Federal Specification MIL–C–5541 shall apply.

Reflector housing shall be provided with a clear plastic cover for each of the lighting segments. The cover shall be connected to the outer longitudinal edge of the fixture by means of hinges. The cover shall be fastened at the bottom of the fixture near the center with a fastening device that will hold the cover securely in place and yet will permit easy access to the lamp sections of the fixture.

b. Reflectors. The reflecting surfaces of each luminaire shall consist of interchangeable sections. Each reflector section shall be pre-formed to the design shape. The design shape shall be submitted to the Engineer for approval prior to the installation of the fixtures.

The aluminum sheet for the reflector shall be 3003 H14 alloy with Type 1175 alloy cladding on the reflective side. The reflective surface shall be mechanically polished prior to anodizing. The finish process shall be performed before or after fabrication of the reflector and shall include

the electrochemical brightening procedure, using an acid process. The minimum weight of the protective oxide coating shall be 5.0 milligrams per square inch. The coating shall be sealed and the reflective surface shall be highly resistant to corrosion, abrasion, staining, fingerprinting, and discoloration and to the long range deleterious effects of vehicle fumes, light, heat (up to two hundred (200) degrees Fahrenheit), water, oils, and aging. The "mirrored" image of a fluorescent lamp on the reflective surface shall have a photometric brightness from edge to edge equal to eighty (80) percent or more of the photometric brightness of the lamp itself when measured with a fluorescent lamp mounted one (1) inch from the reflecting surface and viewing the lamp image from a thirty (30) degree angle from the normal to the flat reflecting surface.

A reflector with weather resistant, oriented polyester plastic film with specular metalized backing bonded to sheet aluminum may be used in lieu of the reflector specified above, providing it conforms to the photometric brightness specified.

c. Lampholders. Lampholders shall be heavy duty, spring loaded type, rated at 1,500 milliamperes and shall be listed by UL for outdoor use without an enclosure. Springs shall not be a part of the current carrying circuit.

The distance between the face of the lampholders for each lamp shall be designed to provide a compression of at least 0.10 inch on the spring type lampholder when the lamp is in place. The lamp shall have positive mechanical and electrical contact when the lamp is in place. The socket on the spring type lampholder shall have sufficient travel to permit installation of the lamp.

d. Lamps. Unless otherwise shown on the plans, lamps shall be 200 watt, 13,250 lumen, 96 inch, T12, cool white, rapid start, fluorescent lamps with recessed double contact bases.

e. Ballasts. One high power factor type ballast, for the 96 inch, T12, fluorescent lamps in the fixture, shall be mounted on the lighting standard as shown on the plans. The ballast shall conform to ASA C82.1 and shall meet the lamp starting requirements at zero (0) degrees Fahrenheit and above, as set forth in ASA C78.

Each ballast shall have a zinc coated steel bracket for side of pole mounting.

f. Conductors. Conductors from ballasts to fixtures shall be No. 10 AWG minimum size and shall conform to the provisions in subsection 623.02.07, "Conductors."

Color coding shall match the coding of the ballast leads.

3. Incandescent Luminaires. Type and style of incandescent luminaires, lamp equipment, and transformers shall be as specified.

All side and end mounted luminaires shall be equipped with a two (2) inch slip-fitter.

All side mounted incandescent luminaires shall be equipped with a porcelain heat barrier bushing, except that for multiple type luminaires, glass sleeving may be used.

4. Soffit and Wall Mounted Luminaires and Lamps. Soffit and wall mounted luminaires shall be of the type or types specified.

Soffit and wall mounted luminaires shall be weatherproof and corrosion resistant. Installation details shall be as shown on the plans.

Each flush-mounted soffit luminaire shall consist of a cast metal body, a prismatic refractor mounted in a door frame, a prismatic glass reflector and a socket. The body shall have a continuous anchor ring and shall be provided with four two (2) inch conduit hubs. The door frame assembly shall be hinged, gasketed, and secured to the body by at least three machine screws. The refractor shall be clearly identified as to "street side" and shall be keyed so as to fit into the frame in only one way.

Unless otherwise specified, each flush mounted soffit luminaire shall be furnished with an integral ballast mounted on a bracket so constructed that the light center of the mercury vapor lamps is within one-half (½) inch of the light center location for which the luminaire is designed. Where an existing flush mounted incandescent soffit luminaire is to be modified, the mounting bracket for the lamp socket or for the integral ballast shall be so designed that the existing tapped holes and machine screws

can be utilized for the attachment of the bracket to the fixture body.

Each pendant soffit luminaire shall be furnished with aluminum finish, one and one-fourth (1¼) inch top-tapped head for internal wiring, stepped or fluted reflector with latch attachment to head and safety chain, and refractor glassware with clampband attachment to reflector. The reflector shall have a specular aluminum anodized and sealed finish. Glassware shall be clearly identified as to "street side."

Each pendant soffit luminaire shall be furnished with an 11 gage minimum thickness, metal box (maximum dimensions of eight by nine by eleven inches (8″ x 9″ x-11″)), and such box shall house the ballast for the luminaire. The box shall be provided with a gasketed cover with two captive screws and two chains to prevent dropping. Box shall be hot-dip galvanized.

Each wall-mounted luminaire shall consist of a cast metal body of the dimensions shown on the plans. The lens frame shall be gasketed and shall allow servicing without detachment from the body.

Cast metal bodies made of aluminum, which are to be flush mounted in concrete, shall be given a heavy coat of alkali-resistant bituminous paint on all surfaces to be in contact with concrete. The paint shall conform to Federal Specification MIL–P–6883.

Unless otherwise specified, each soffit luminaire and each wall mounted luminaire shall be furnished with a hard glass type, 175 watt, mercury vapor lamp, ASA Type H 39–22KB, with a minimum average rated life of 16,000 hours. Each lamp socket shall be either repositioned or provided with an extension to locate the light center of the lamp within one-half (½) inch of that of a seven (7) inch light center lamp installed in the fixture.

5. Pedestrian Undercrossing Fixtures—Fluorescent. Pedestrian undercrossing fluorescent lighting fixtures shall conform to the details shown on the plans and as provided hereafter.

The design of the fixture shall be submitted to the Engineer for approval before fabrication of the fixture is

started. If deemed necessary by the Engineer, one complete prototype fixture shall be delivered to the Engineer for approval at least thirty (30) calendar days before fabrication of the contract fixtures.

The shell of the fixture shall be of cast aluminum alloy, industrial type or Federal Class 18 aluminum, one-fourth (¼) inch minimum thickness.

The door shall be one piece of 6061 T6 aluminum alloy, one-eighth (⅛) inch minimum thickness.

The "Zee" bars and clip angles shall be 3003 H15 or 5005 H14 aluminum alloy, one-sixteenth ($\frac{1}{16}$) inch minimum thickness.

Lens units shall consist of one and one-half (1½) inch methyl-methacrylate rod, cut and fire glazed to provide a clear finish. Units shall conform to the dimensions shown on the plans.

The continuous piano hinge shall be of Type 1100 aluminum alloy. The piano hinge shall be riveted to the door section with one-eighth (⅛) inch aluminum rivets. Matching holes shall be drilled in the piano hinge and the lower edge of the fixture. The door assembly shall be attached after the shell is in place by three-eighths (⅜) inch 8–32 stainless steel, self-tapping screws.

A captive, positive keyed, screw-type, latching device requiring a special wrench, shall be provided at the upper edge to secure the door in the closed position as shown on the plans. Two special wrenches shall be delivered to the Engineer.

A neoprene gasket shall be attached to the frame to provide a cushion between the shell and the door.

A chain or other satisfactory device shall be provided to prevent the door from coming in contact with the undercrossing wall when in the fully open position.

The fixture shall be held in place by three three-eighths by eight inch (⅜″ x 8″) anchor bolts with two nuts as shown on the plans.

Surfaces of the fixtures in contact with concrete and with anchor bolts and nuts shall be painted with a heavy coat of alkali-resistant bituminous paint. The paint shall conform to Federal Specification: MIL–P–6883.

Each fixture shall contain a forty-eight (48) inch, T12,

reflectorized, rapid start, fluorescent lamp with thirty (30) degree aperture and with recessed, double contact base installed on the back side of the door directly behind the lens.

Lampholders shall be listed by UL for outdoor use without an enclosure and with 1,500 milliamperes, rapid start, fluorescent lamps. One lampholder for each lamp shall be of the spring loaded type.

The distance between the face of the lampholders for each lamp shall be designed to provide a compression of at least 0.10 inch on the spring type lampholder when the lamp is in place. The lamp shall have positive mechanical and electrical contact when the lamp is in place. The socket on the spring type lampholder shall have sufficient travel to permit installation of the lamp. Springs shall not be a part of the current carrying circuit.

The ballast shall be of the high power factor type with weatherproof leads for operation of one forty-eight (48) inch rapid start lamp. Ballasts shall be listed by UL for outdoor operation on 110–125 volt, 60 cycle circuits and rated at 1,500 milliamperes.

All wiring connections in the fixtures shall be terminated on a molded, phenolic, barrier type, two-pole terminal block rated at 15 amperes, 600 volts and shall have integral type, white waterproof marking strips. All current carrying parts of the terminal blocks shall be insulated from the fixture with integral plugs or strips to provide an insulating value in excess of the line to ground flashover voltage. If the Contractor elects to use sectionalized terminal blocks each section shall be provided with an integral barrier on each side and shall be capable of rigid mounting and alignment.

Conductors from terminal block to lampholders shall be No. 16 AWG minimum size, stranded, copper wire with TW or TF insulation, labeled by UL, rated at 600 volts and conforming to ASTM Designation D734. Splicing of lampholder conductors to the ballast leads shall be done by use of mechanically secure connectors. Color coding shall match the coding of the ballast leads.

Sufficient slack shall be provided in conductors to allow the fixture door to be fully opened.

Holes for one (1) inch conduit shall be provided in both ends of the fixture. Unused holes shall be plugged with pressed metal closures.

Exposed surfaces of the fixture shall be clean, uniform in appearance, and free from defects such as improper fit, dents, deep scratches and abrasions, burrs, roughness, off-square ends, holes off center or jagged, surface irregularities, and other significant defects. Screws for attaching all components to fixture door such as "Zee" bars, ballast, and terminal block shall be tapped into door from inside only. No screwheads, nuts, or other fasteners shall be removable from the outside.

Any defective parts of the fixture, as determined by the Engineer, before or after the fixture is installed, shall be removed and replaced.

6. Sign Lighting Fixtures—Fluorescent. Each fluorescent sign lighting fixture shall be designed for mounting at the bottom of the sign on an overhead sign structure as shown on the plans. The fixture shall be a fully enclosed type, raintight, dust-tight, corrosion-resistant, with hinged plastic cover. The fixture shall contain one lamp for signs up to seventy (70) inches in vertical dimension and two lamps for signs seventy (70) inches to and including one hundred twenty (120) inches in vertical dimension.

Painting of fixtures will not be required.

The light distribution of the fixture shall conform to the following:

Fixture	Candlepower	Angle from Base Line	
One lamp	200 Max.	0 Degrees	
	350 Min.	10 Degrees	(low angle)
	1,000 Min.	48 Degrees	(high angle)
Two lamp	200 Max.	0 Degrees	
	350 Min.	10 Degrees	(low angle)
	2,500 Min.	66 Degrees	(high angle)

The ratio between high and low angle luminous intensities shall be between 2:1 and 3:1 for one-lamp fixtures and between 3:1 and 10:1 for two-lamp fixtures, with the higher ratios being preferable. Maximum intensity shall be at the high angle specified, plus or minus five (5) degrees.

Luminous intensities shall be measured at a test distance of thirty (30) feet with fixture in a still air ambient

temperature of seventy (70) degrees Fahrenheit. The "angle from base line" shall be the angle (on the sign side of the fixture) between a line parallel to the bottom surface of the fixture and the line along which measurements are to be taken, both lines at right angles to the length of the test unit. The lamps in the fixtures shall be operated so that each lamp will produce a corrected output of 3,400 lumens.

a. Housing. The shell of the fixture shall be fabricated of 0.064 inch minimum thickness, 3003 H14 aluminum alloy sheet with Type 7072 alloy cladding or fabricated of other material which will provide equivalent strength and corrosion resistance.

Maximum dimensions of the housing shall be seventy four (74) inches long (for seventy-two (72) inch nominal lamps), fourteen (14) inches wide and four (4) inches high.

All external machine screw parts, lock washers, hinge pins, etc., shall be made of Type 316 stainless steel, except when otherwise shown on the plans.

b. Reflector. The reflector shall be fabricated of 0.020 inch minimum thickness, 3003 H14 aluminum alloy sheet with Type 1175 alloy cladding on the reflective side.

The reflector surface shall be mechanically polished prior to anodizing. The finish process shall be performed before or after fabrication of the reflector and shall include the electrochemical brightening procedure using an acid process. The minimum weight of the protective oxide coating shall be fifty (50) milligrams per square inch. The coating shall be sealed.

The reflector may be constructed of weather-resistant, oriented polyester plastic film with specular metalized backing bonded to sheet aluminum in lieu of the reflector specified herein, providing it conforms to the photometric specification.

Reflectors shall be protected during forming and assembling with secure coverings which shall be removed after the assembly has been completed. Reflectors shall have hemmed edges for safe handling.

c. Cover. Cover shall be of acrylic material.

Each plastic cover shall latch easily and securely in

place without the use of tools and shall be completely free from any tendency to loosen under high winds and vibration. The cover shall be fitted with non-stretching safety cords, chain safety devices, or equivalent, which shall also serve as stops when the cover is hinged open.

d. Gaskets. Gaskets shall be uniform and even textured. Gaskets shall be neatly applied to thoroughly degreased, clean surfaces with a suitable heat resistant adhesive, which will not allow the gaskets to slip at a temperature of one hundred sixty (160) degrees Fahrenheit (continuous).

e. Ballasts. Ballasts shall be of the high power factor type and shall be capable of starting the lamps at zero (0) degrees Fahrenheit and above. Ballasts shall be for slimline lamps. Ballasts shall be listed by UL or Electrical Testing Laboratories for outdoor operation on 110–125 volt, 60 cycle circuits and shall conform to the requirements of ASA C82.1 and ASA C82.2.

f. Lampholders. High voltage lampholders shall be listed by UL with a rating of 1,000 volts. Low voltage lampholders shall be listed by UL with a rating of 600 volts and shall de-energize the primary system of the ballast when a lamp is removed. No live parts shall be exposed during relamping. Lampholders shall be capable of accepting slimline lamps.

The distance between the face of the lampholders for each lamp shall be designed to provide a compression of at least 0.10 inch on the spring-type lampholder when the lamp is in place. The lamp shall have positive mechanical and electrical contact when the lamp is in place. The socket on the spring-type lampholder shall have sufficient travel to permit installation of the lamp.

g. Lamps. Each fixture shall use one or two 72T8, cool white, slimline, fluorescent lamps which shall meet the requirements of ASA C78.

The lamps shall operate in pairs from two-lamp ballasts, wherever possible. Two-lamp ballasts shall be the lead-lag type. Single or unpaired lamps shall be operated from a single lamp ballast.

h. Terminal Blocks. All wiring connections in the fixtures and on the ballast chassis shall be terminated on

a molded, phenolic, barrier type, two-pole terminal block rated at 15 amperes, 1,100 volts, and shall have integral type, white waterproof marking strips. All current carrying parts of the terminal blocks shall be insulated from the fixture with integral plugs or strips to provide an insulating value in excess of the line-to-ground flashover voltage. If the Contractor elects to use sectionalized terminal blocks, each section shall be provided with an integral barrier on each side and shall be capable of rigid mounting and alignment.

i. Fuses. Fuses shall be of the miniature, slow blowing type, with appropriate current and voltage rating. Fuse blocks shall be of the open clip type with phenolic base and screw terminals.

j. Conductors. Conductors from ballasts to fixtures and fixture wires shall be No. 16 AWG minimum, stranded, copper wire with two sixty-fourths ($^{2}/_{64}$) inch plasticized polyvinyl chloride insulation, labeled by UL and conforming to "Standard for Flexible Cord and Fixture Wire" and "Proposed Investigation Thermoplastic Insulation Appliance Wiring Material Rated 80C or 90C and 1,000 Volts," for use in 1,000 volt fluorescent light circuits. Lampholder conductors shall be of sufficient length to extend from the high-voltage sockets to fixture terminal block. If splicing is necessary, the splice shall be insulated to a rating equal to or greater than that of the fixture wire.

Color coding shall match the coding of the ballast leads.

7. Sign Lighting Fixture—Incandescent. Each sign lighting fixture with an incandescent lamp shall be of the type as specified in the contract documents.

Sign reflector fixtures shall be UL approved for outdoor installation. The fixture shall consist of a cast iron hood with side outlet tapped for conduit and a symmetrical eight (8) inch steel reflector. The hood shall be cadmium plated and finished with aluminum paint.

The reflector shall have porcelain enameled finish, green on outside and white on inside.

The fixture shall be furnished complete with 1900 lumen traffic signal lamps.

8. Flashing Beacons. Where shown on the plans, flashing beacons shall be installed. Each beacon shall consist of a single section traffic signal head, conforming to the provisions in subsection 623.02.11(b)1., "Signal Faces," with yellow or red lens as shown on the plans. Mounting of beacons, including spanwire mounting if required, shall be as shown on the plans.

Each flashing beacon control unit shall consist of a switch, 10 ampere plug fuse, radio interference suppressor, flasher, and terminal block housed in a single enclosure. The enclosure shall be NEMA Type 3R, galvanized in accordance with the provisions in subsection 623.02.10, "Galvanizing," and shall be provided with top hinged cover and a hasp for sealing cover. Padlocks will be furnished by others.

Switches shall be 10-ampere, toggle type, single-pole, two-wire, 120 volt, AC and shall be mounted at the top and center of the dead front panel.

Radio interference suppressors shall conform to the provisions in subsection 623.02.11(a)5., "Radio Interference Suppressors."

The flasher shall be either a motor-driven device or an electronic device without tubes.

Contacts shall be fine silver, silver alloy, or superior alternative material not less than three-eighths (⅜) inch diameter, rated at 20 amperes, 115 volts.

Flashers shall provide 50 to 60 flashes per minute, with equal on and off intervals.

Flashers shall provide for two-circuit, alternate operation of beacons and shall be furnished with plug-in mounting.

Terminal blocks shall be rated at 15 amperes, 600 volts, shall be molded from phenolic material and shall be the barrier type with plated brass screw type terminals and integral type marking strips.

Workmanship and materials shall be equal to that of first class electrical instruments.

When flashing beacons are installed adjacent to or in conjunction with a traffic signal system, the flasher control shall be installed in the controller cabinet unless otherwise shown on the plans.

9. Photoelectric Controls. Photoelectric controls, as specified in the special provisions or as shown on the plans, shall be capable of switching multiple lighting systems directly or of switching series lighting systems through a high voltage controller.

a. Types. The types of photoelectric controls shall be as follows:

Type 1 photoelectric control shall consist of a photoelectric unit and a contactor in a single weatherproof housing.

Type 2 photoelectric control shall consist of a photoelectric unit in a weatherproof housing and a separate contactor located in a traffic signal controller cabinet.

Type 3 photoelectric control shall consist of a photoelectric unit and a separate contactor, each in a separate weatherproof housing.

Photoelectric controls for pole-top mounting shall be furnished with slip-fitter, with minimum inside diameter of four (4) inches, terminal block, and with cable supports or clamps to support pole wires.

A switch to permit manual operation of the lighting circuit shall be provided for each photoelectric control. Switches shall be of the single-hole mounting toggle type, single-pole, single-throw, rated at 12 amperes, 125 volts. Switches shall be furnished with an indicating nameplate reading "Auto-Test" and shall be connected in parallel with the load contacts of the photoelectric unit.

b. Equipment Details. Equipment details shall conform to the following:

Photoelectric Unit. The photoelectric unit shall consist of a light-sensitive element connected directly to a control relay without intermediate amplifications. The unit may be either the horizontal-sensing or zenith-sensing type and shall have a "turn-on" between one and five foot-candles and a "turn-off" at between one and one-half and five times "turn-on."

The photoelectric unit shall be the pole-top mounting type with slip-fitter, except that mounting brackets shall be used where pole-top mounting is not possible, installed at the locations shown on the plans and oriented as directed by the Engineer.

The photoelectric unit shall also conform to the following:

The supply voltage rating shall be 60-cycle, 105–130 or 210–240 volts, as required.

The load rating shall be 800 watts minimum, incandescent, mercury vapor or fluorescent.

The operating temperature range shall be from minus twenty (20) degrees Fahrenheit to plus one hundred fifty (150) degrees Fahrenheit.

The power consumption shall be less than 10 watts.

The base of the unit shall be provided with a 3-prong, EEI–NEMA standard, twist-lock plug mounting.

Contactor. The contactor shall have contacts rated to switch the specified lighting load and shall be normally open, unless otherwise specified.

The contactor shall be the mechanical armature type consisting of an operating oil, a laminated core, a laminated armature, contacts, and terminals. Contacts shall be fine silver, silver alloy, or superior alternative material.

Contactor and Test Switch Housing. For Type 3 control, the contactor and test switch shall be housed in a suitable NEMA Type 3R enclosure, galvanized in accordance with the provisions in subsection 623.02.10, "Galvanizing." A minimum of two and one-half (2½) inches shall be provided between contactor terminals and end of enclosure for wiring connections. For Type 1 control, the enclosure shall house the test switch only. The raintight enclosure shall be mounted on the same standard as the photoelectric unit at a height of approximately six (6) feet above the base.

For Type 2 control, the test switch shall be housed in the traffic signal controller cabinet with the contractor.

Wiring. Conductors between the photoelectric unit and an external contactor shall be No. 14 AWG and shall be run inside the lighting standard, or in conduit, unless otherwise shown on the plans.

10. Series Multiple Relays. Each series multiple relay shall be a single-pole, normally open, single unit relay in a weatherproof enclosure designed for pole mounting. The operating coil shall be designed and insulated for connecting directly into a high-voltage series lighting circuit.

The load rating shall be 40 amperes, 125 volts, AC, unless otherwise specified in the contract documents.

11. Series Multiple Transformers. Each series multiple transformer shall operate a 110 volt to 125 volt multiple load from a single-phase, 60 cycle, 6.6 ampere constant current, series circuit. Rating of the transformer shall be as shown on the plans.

The secondary voltage shall have a permissible range from 118 volts (±3%) at full load to 130 volts maximum at no load.

Transformers shall be insulated for operation on 5,000 volt circuits and shall operate at rated volt-amperes continuously without exceeding fifty-five (55) degrees Centigrade temperature rise above a forty (40) degree Centigrade ambient temperature as measured by change in winding resistance.

The case shall be No. 16 gage, noncorrosive, pole base type. Three noncorrosive cable entrance sleeves, a minimum of one (1) inch in length, shall be provided. The sleeves shall be suitable for taped joints, without threads or wiping sleeve features. The unit shall be filled with a high melting point insulating compound and shall be hermetically sealed to insure satisfactory operation under continuous submersion in water. The core and coil shall be mechanically attached to the case.

Transformer leads shall be insulated with non-hygroscopic material. Primary leads shall conform to the requirements in subsection 623.02.07, "Conductors." There shall be two single-conductor primary leads and one two-conductor secondary lead extending nine (9) inches minimum outside of the sleeves. The secondary lead shall be a two-conductor, No. 12 AWG cable insulated for 600 volts.

Casing and cover shall be coated with a moisture resistant paint.

12. Ballasts. Ballasts for mercury vapor lamps shall be designed for the primary current and types of lamps specified in the contract documents.

Ballasts shall provide reliable lamp starting down to minus twenty (20) degrees Fahrenheit.

a. Multiple Circuit Ballasts. Power factor for multiple ballasts shall be better than ninety (90) percent and losses shall be less than fifteen (15) percent of lamp watts.

At the option of the Contractor, mercury vapor lamp ballasts for 120 volt, 240 volt, or 480 volt multiple circuits may be included as an integral part of the luminaire.

Ballasts for multiple circuits shall be constant wattage type with nominal primary voltage rating of 120/140 or 240/480 and with lamp current wave shape crest factor not to exceed 2.0 at rated line voltage.

Integral ballasts for pedestrian and soffit luminaires shall be of high-reactance lag-type for operation of a single 175 watt mercury vapor lamp on a nominal primary voltage of 120 volts. Two primary taps shall be provided, one above and one below 120 volts.

b. Series Circuit Ballasts. Primary and secondary windings shall be completely wrapped with layers of irradiated polyethylene tape to a minimum thickness of one-eighth (⅛) inch. The layers of tape shall be fused together by heating to insure the exclusion of moisture and other contaminants. The complete assembly shall be dipped in insulating material conforming to ASA C89.1, Class F or H, capable of withstanding an operating temperature of one hundred fifty-five (155) degrees Centigrade to provide a moistureproof coating.

The voltage insulation of primary and secondary windings and associated leads shall meet or exceed the requirements of ASA C82.7.

Name plate data shall conform to ASA C82.7.

Rubber covered leads of non-integral ballasts shall be non-hygroscopic and the entrance of the leads into the ballasts shall have a watertight seal.

Ballasts installed in pull boxes shall be protected from moisture by either encasing ballast in a neoprene waterproof jacket or constructing ballast with aluminum, brass, or galvanized steel casing and cover. The casing and cover shall be coated with a moisture resistant paint.

Each ballast to be installed in a pull box shall be provided with a handle and hanger as detailed on the plans.

Ballasts for use for soffit luminaires shall conform to the following:

Ballast shall be furnished with mounting brackets attached and shall be equipped with terminal blocks for primary connections and lamp socket preconnected to the secondary for flush mounted luminaires and with terminal blocks for both primary and secondary connections for use with suspended luminaires.

13. Step Down Transformers. Step down transformers in 480 volt circuits shall be 480/120 volt, 60 cycle type with volt-ampere ratings as shown on the plans. Transformers shall carry rated volt-amperes continuously without exceeding eighty (80) degrees Centigrade. Temperature rise above forty (40) degrees Centigrade ambient. The high voltage coil shall have two five (5) percent full capacity taps below normal. The low voltage coil may be either a single 120 volt coil or two 120 volt coils which may be parallel connected for 120 volt operation or series connected for 120–240 volt, three-wire operation.

The case shall be fabricated of aluminum, brass or galvanized steel. The case shall be coated with moisture resistant paint.

The unit shall be filled with a high melting point compound and shall be hermetically sealed to insure satisfactory operation under continuous submersion in water.

Transformer leads shall be insulated with non-hygroscopic material and shall extend at least nine (9) inches outside case seal.

Each transformer to be installed in a pull box shall be provided with a handle and hanger as detailed on the plans.

CONSTRUCTION

623.03.01 General. All electrical construction shall be carried out by competent crews under the direction of able foremen of the Contractor, or by the manufacturer's representatives. All workmanship shall be complete and in accordance with the latest accepted standards of the industry, as determined by the Engineer and the standard specifications that follow.

Failure of the Engineer to note faulty workmanship during construction shall not relieve the Contractor of the responsibility for correcting the faults at his own expense.

623.03.02 Foundations. In placing concrete foundations for detectors, concrete shall be worked up between the channels by mechanical vibrating methods. The detector contact unit shall be removed during the time of installation. One (1) inch inspection holes shall be provided at one (1) foot intervals, placed uniformly along each side of the centerline of nonremovable contact unit mounting pans. Concrete shall be worked up through the holes so as to insure that there are no voids below the contact unit mounting pan. Where the detector contact unit mounting pan is removable, concrete shall be smoothed even with pan support angles. The detector frame shall be set and the concrete shall be finished flush and true with the pavement surface.

Concrete foundations shall rest on firm ground.

Foundations shall be placed "in the solid" and monolithic where practicable. For posts, standards, and pedestals not on structures, the top two (2) inches of the concrete foundation shall be placed after the post, standard, or pedestal is in proper position. The exposed portions of the foundation shall be formed to present a neat appearance.

After each post, standard, or pedestal on structures is in proper position, grout shall be placed under the base plate. The exposed portions shall be formed to present a neat appearance. Grout shall consist of one part by volume of Portland cement and three parts of clean sand, shall contain only sufficient moisture to permit packing, and shall be cured by keeping it damp for three (3) days.

Forms shall be true to line and grade. Tops of foundations for posts and standards, except special foundations, shall be finished to curb or sidewalk grade or as directed by the Engineer. Forms shall be rigid and securely braced in place. Conduit ends and anchor bolts shall be placed in proper position and to proper height, and shall be held in place by means of a template until the concrete sets.

Plumbing of standards shall be accomplished by adjusting nuts before grouting or before the foundation is finished to final grade. Shims, or other similar devices for plumbing or raking of posts, standards, or pedestals will not be permitted.

Both forms and ground which will be in contact with the concrete shall be thoroughly moistened before placing concrete. Forms shall not be removed until the concrete has thoroughly set.

Ordinary surface finish, as specified in subsection 502.-03.18, "Ordinary Surface Finish," shall be applied to exposed surfaces of concrete.

Where obstructions prevent the construction of a planned foundation, the Contractor shall construct an effective foundation satisfactory to the Engineer.

The foundations shown on the plans shall be extended if conditions require additional depth, and such additional work, if ordered by the Engineer, will be paid for as extra work as provided in subsection 104.03, "Extra Work."

Unless otherwise shown on the plans, all standards to be relocated shall be provided with new foundations.

When a foundation is to be abandoned in place, the top of foundation, anchor bolts, and conduits shall be removed to a depth of five-tenths (0.5) foot below surface of sidewalk or unimproved ground. The resulting hole shall be backfilled with material equivalent to the surrounding material.

623.03.03 Excavating and Backfilling. The excavations required for the installation of conduit, foundations and other appurtenances shall be performed in such a manner as to avoid any unnecessary damage to street, sidewalks, landscaping, and other improvements. The trenches shall not be excavated wider than necessary for the proper installation of the electrical appurtenances and foundations. Excavation shall not be performed until immediately before installation of conduit and other appurtenances. The material from the excavation shall be placed in a position that will not cause damage or obstruction to vehicular and pedestrian traffic nor interfere with surface drainage.

Unless otherwise permitted in writing by the Engineer, all surplus excavated material shall be removed and disposed of within forty-eight (48) hours outside the highway right of way in accordance with the provisions in subsection 107.14, "Disposal of Material Outside the Highway Right of Way."

The excavations shall be backfilled in conformance with the provisions in Section 207, "Backfill."

Excavations after backfilling shall be kept well filled and maintained in a smooth and well-drained condition until permanent repairs are made.

All excavations shall be filled, and sidewalks, pavement, and landscaping restored at each intersection prior to excavating at any other intersection, unless otherwise permitted by the Engineer.

Excavations in the street or highway shall be performed in such a manner that not more than one traffic lane is restricted in either direction at any time.

623.03.04 Removing and Replacing Improvements. Improvements such as sidewalks, curbs, gutters, Portland cement concrete and asphalt concrete pavement, base material, lawns, and plants, and any other improvements removed, broken, or damaged by the Contractor's operations, shall be replaced or reconstructed with the same kind of material as found on the work or with materials of equal quality. The new work shall be left in a serviceable condition satisfactory to the Engineer.

Whenever a part of a square or slab of existing concrete sidewalk or driveway is broken or damaged, the entire square or slab shall be removed and the concrete reconstructed as above specified.

The outline of all areas to be removed in Portland cement concrete sidewalks and driveways and in pavements shall be cut to a minimum depth of one and one-half (1½) inches with an abrasive type saw prior to removing the sidewalk, driveways, and pavement material. The cut for the remainder of the required depth may be made by a method satisfactory to the Engineer. Cuts shall be neat and true with no shatter outside the removal area.

623.03.05 Standards, Steel Pedestals, and Posts. Standards for traffic signals and electroliers, and steel pedestals for cabinets and other similar equipment shall be located as shown on the plans.

Posts, poles, standards, and pedestals, except concrete

pedestals cast in place, shall not be erected until the foundation has set at least seventy-two (72) hours.

Holes left in the shafts of existing standards, due to removal of equipment or mast arms, shall be repaired by welding in a suitable disk, grinding smooth and painting as provided for repairing damaged galvanized surfaces in Section 715, "Galvanizing."

When directed by the Engineer, existing standards to be relocated or reused in place shall be repaired prior to repainting or regalvanizing. Large dents shall be removed, shafts shall be straightened and portions which are in poor condition due to corrosion or damage shall be replaced. Extent of repairs or replacements will be determined by the Engineer and said repairs or replacements ordered by the Engineer will be paid for as extra work as provided in subsection 104.03, "Extra Work."

623.03.06 Conduit. All conductors shall be run in conduit, except for overhead and temporary installations and where conductors are run inside poles.

Conduit and fittings to be installed on the surface of poles or in structures and foundations shall be rigid metal type as specified above for underground installations.

All conduit installed on the surface of poles or structures or other exposed locations shall be unpainted zinc coated metal.

Where nonmetallic conduit is to be installed, the conduit run between a structure and the nearest pull box shall be of the rigid metal type.

Installation of conduit shall conform to the provisions of the Code.

Where a pull box is installed adjacent to the base of a standard (except a traffic signal standard) or a sign structure post, conduit installed from the pull box to the standard or post shall not be less than one and one-half (1½) inches in diameter.

Where pull boxes are installed adjacent to the base of a signal standard or controller pedestal, conduit installed between pull boxes and the standard or pedestal shall not be less than two (2) inches in diameter, unless otherwise shown on the plans.

It shall be the option of the Contractor, at his expense, to use conduit of larger size than shown on the plans, if desired, and where used, it shall be for the entire length of the run from outlet to outlet. No reducing couplings will be permitted.

The ends of all conduits, whether shop or field cut, shall be reamed to remove burrs and rough edges. Cuts shall be made square and true so that the ends will butt or come together for the full circumference thereof. Nonmetallic type conduit shall be cut with a hacksaw or other approved tool. Nonmetallic type conduit connections shall be made of the solvent weld type. Slip joints or running threads will not be permitted for coupling conduit. When a standard coupling cannot be used for coupling metal type conduit, an approved threaded union coupling shall be used. The threads on all ferrous metal conduit shall be painted with rust preventive paint before couplings are made up. All couplings for metal type conduit shall be screwed up until the ends of the conduits are brought together, providing a good electrical connection througout the entire length of the conduit run. Where the coating on ferrous metal conduit has been damaged in handling or installing, such damaged places shall be painted with rust preventive paint.

Exposed ungalvanized threads on ferrous metal type conduit resulting from field cuts shall be painted with rust preventive paint.

All metal type conduit ends shall be threaded and shall be capped with standard pipe caps until wiring is started. When caps are removed, the threaded ends shall be provided with approved conduit bushings. Nonmetallic type conduit ends shall be capped until wiring is started.

Nonmetallic conduit fittings for connecting nonmetallic conduit to rigid metal conduit shall be threaded on the metal conduit side.

Conduit stubs from electrolier bases shall extend at least six (6) inches from face of foundation and at least eighteen (18) inches below top of foundation. Conduit stubs on structures shall be as shown on the plans.

The location of ends of all conduits in structures, or terminating at curbs, shall be marked by a "Y" at least

three (3) inches high cut into the face of curb, gutter, or wall, directly above the conduit and above grade line.

Conduit bends, except factory bends, shall have a radius of not less than six times the inside diameter of the conduit. Where factory bends are not used, conduit shall be bent, without crimping or flattening, using the longest radius practicable.

Conduit shall be laid to a depth of not less than eighteen (18) inches below the curb grade in the sidewalk areas and curbed paved median areas, twenty-four (24) inches below highway pavement grade in road areas and finished grade in all other areas, except that conduit may be laid on top of the existing pavement within new curbed median strips being constructed on top of said pavement.

Existing pavement shall not be disturbed without the approval of the Engineer. Where conduit is to be placed under existing pavement, a hole larger than the conduit shall be predrilled and the conduit installed by hand. In the event obstructions are encountered, upon approval of the Engineer, small test holes may be cut in the pavement to locate obstructions. Jacking may be used when a pipe of sufficient diameter to contain the conduit is used as a sleeve for the conduit. The conduit shall be installed in the sleeve by hand.

Jacking or drilling pits shall be kept two (2) feet clear of the edge of any type of pavement wherever possible. Excessive use of water, such that pavement might be undermined or subgrade softened, will not be permitted.

Bottom of trenches for rigid nonmetallic conduit shall be relatively free of sharp irregularities which would cause pinching and excessive bending of the conduit. The first six (6) inches of backfill shall be free of rocks.

Conduit to be placed beneath railroad tracks shall comply with the following:

The conduit shall be wrapped rigid metal type, one and one-half (1½) inch minimum size and shall be placed to a minimum depth of three (3) feet below bottom of tie.

The near side of each conduit jacking pit shall be constructed not less than twelve (12) feet from the centerline of track.

When the jacking pit is to be left overnight it shall be substantially covered with planking in a manner satisfactory to the Engineer.

Conduit terminating in standards or pedestals shall extend approximately two (2) inches vertically above the foundation and shall be sloped towards the handhole opening. Conduit entering concrete pull boxes shall terminate two (2) inches inside the box wall and not less than two (2) inches above the bottom, and shall be sloped toward top of box to facilitate pulling of conductors. Conduit entering through the bottom of a pull box shall be located near the end walls to leave the major portion of the box clear. At all outlets, conduits shall enter from the direction of the run.

Conduit for future use in structures, leading to points below grade of pull box, shall be threaded and capped.

Where existing rigid metal conduit systems are to be modified or extended, rigid metal conduit only shall be installed.

Where new pull boxes are placed in existing conduit runs, the conduit shall be fitted with threaded bushings and bonded.

Conduit run on the surface of structures shall be secured with galvanized malleable iron clamps spaced not more than five (5) feet apart.

Conduit leading to soffit, wall, or other lights or fixtures below the grade of the pull box shall be sealed by means of an approved sealing fitting and sealing compound.

Attention is directed to subsection 623.03.09, "Bonding and Grounding."

A No. 12 AWG TW insulated copper pull wire shall be installed in all conduits which are to receive future conductors. At least two (2) feet of pull wire shall be doubled back into the conduit at each termination.

Existing underground conduit without conductors to be incorporated into a new system shall be cleaned with a mandrel or cylindrical wire brush and blown out with compressed air.

Conduit runs shown on the plans may be changed

with the approval of the Engineer, to avoid underground obstructions.

623.03.07 Pull Boxes. Pull boxes shall be installed at the locations shown on the plans, or in long runs, they shall be spaced at not over two hundred (200) feet. It shall be the option of the Contractor, at his expense, to install additional pull boxes that he may desire to facilitate his work.

Tops of pull boxes shall be flush with the surrounding grade or top of adjacent curb, except that in unpaved areas where a pull box is not immediately adjacent to and protected by a concrete foundation, pole or other protective construction, the box shall be buried twelve (12) inches below grade and shall be marked by a pull box marker placed adjacent to the pull box. Where practical, pull boxes shown in the vicinity of curbs shall be placed adjacent to the back of curb, and pull boxes adjacent to standards shall be placed along the side of foundations as shown on the plans.

623.03.08 Wiring. Wiring shall conform to the provisions of the Code.

Powdered soapstone, talc, or other inert lubricant shall be used in placing conductors in conduit.

Where conduit is of the nonmetallic type, conductors shall be pulled by hand and the use of winches or other power actuated pulling equipment will not be permitted.

All signal light conductors, except branch neutrals, shall be run continuously without splices from a terminal block located in a cabinet, compartment, or signal head, to a similarly located terminal block. Signal light conductors shall not run to a terminal block on a standard unless they are to be connected to signal head that is mounted thereon.

Branch signal light neutrals may be spliced in pull boxes.

Where an existing signal system is being modified, the signal conductors may be spliced where shown on the plans.

When new conductors are to be added to existing conductors in the conduit, all conductors shall be removed

and both old and new conductors shall be pulled through as a unit.

Sufficient signal light conductors shall be provided to perform the functional operation of the signal system and, in addition thereto, three spare conductors of size equal to the largest signal light conductor in the run, except neutral, shall be provided throughout the signal light system, unless otherwise shown on the plans. At least five (5) feet of slack shall be left for each conductor at each signal or lighting standard, or combined standard, and at least two (2) feet of slack at each pull box. Where signal or series lighting conductors are contained in a conduit within the standard, the five (5) feet of slack in conductors will not be required.

Where signal conductors are run in lighting standards containing high-voltage series street lighting conductors, either the signal conductors or the lighting conductors shall be encased in flexible or rigid metal conduit, to a point where the two types of conductors are no longer in the same raceway. Where telephone circuits are installed adjacent to high voltage circuits, the telephone conductors shall be encased in flexible metal conduit.

Where pressure sensitive vehicle detectors are to be installed, a separate conductor, except neutral, shall be run continuously without splices for the controller cabinet to each detector element. The detector neutral conductor, when required, and the neutral for pedestrian push button circuits shall be separate from the signal light circuit neutral. Branch neutrals may be spliced in pull boxes.

The shield of shielded cable shall be grounded at the amplifier or transceiver chassis.

Where ballasts or transformers are used, series lighting conductors shall be run from ballast to ballast, transformer to transformer, and from ballast or transformer to service. Splices will be permitted only at ballasts or transformers, except where runs are more than four hundred (400) feet between units.

Where ballasts or transformers are not used, series lighting cable shall be run without splices from luminaire to luminaire and from service to luminaire.

Multiple lighting conductors may be spliced in bases of standards or in pull boxes adjacent thereto.

Where more than one conductor enters a ballast sleeve, the insulation and taping shall be applied between the conductors in such a manner as to provide a watertight joint. The splice shall be capable of satisfactory operation under continuous submersion in water.

Conductors shall be joined by the use of approved connectors, or other methods approved by the Engineer. All splices, with or without connectors, shall be soldered by the pouring or dipping method.

Soldering of pressure connectors may be omitted provided the connectors are applied with a ratchet type crimping tool which will not release the connector until the crimping operation is completed. The sleeve shall be compressed on the end. The finished connection shall comply with the requirements of Federal Specification MIL–T–7928.

Conductor insulation shall be well penciled, trimmed to conical shape and roughened before applying splice insulation. Splice insulation shall consist of layers of thermoplastic electrical insulating tape not over seven thousandths (0.007) inch thick conforming to Federal Specification MIL–I–7798, applied to a thickness equal to and well lapped over the original insulation, except that on high voltage and multiple lighting conductor splices, two layers of synthetic oil resistant rubber tape conforming to the requirements of the current ASTM Designation D119, shall be applied over the conductor before placing the thermoplastic tape. The splice shall then be well covered with at least two layers of asphalt impregnated open mesh fabric tape, and a coating of high grade insulating paint or similar material. At least two (2) feet of slack shall be left for each conductor at each splice.

In lieu of the splice insulation shown on the plans, the Contractor may elect to use, without soldering, either:

(a) A cast insulation of self-curing epoxy resin which is compatible with wire insulation to form a moisture resistant joint. The resin shall be resistant to weather and aromatic and straight chain solvents and, in addition, shall

not sustain combustion. The resin shall be poured into molds of dimensions suitable for the splice; or

(b) A pin and receptacle, locking type connector with waterproof housing, capable of being disconnected without damage.

The pin shall be of medium hard copper material with the portion to be crimped onto the conductor fully annealed.

The receptacle shall be of copper material fully annealed.

The pin and the receptacle shall be of such size that they shall have at least ninety (90) percent conductivity when crimped onto the conductor ends.

Both the pin and the receptacle shall have centrally located recessed locking areas which shall match complementary areas of the housing.

The receptacle shall establish contact pressure with the pin through the use of a copper beryllium sleeve spring and the receptacle and pin shall lock together so that the connection will be maintained when a minimum force of twenty (20) pounds tension pull is applied to the attached conductors.

Separate housings shall be provided for the pin and the receptacle, each housing made of water resisting, synthetic rubber suitable for direct burial in the ground or installation in the direct sunlight.

Each housing shall have an interior arrangement, complementary to the pin and the receptacle, suitable to receive and securely retain the pin and the receptacle, also a section to form a water-seal around the conductor and also a section to provide a water-seal between the housings at the point of disconnection.

A small slot or vent shall be provided along the housings to permit the exclusion of air. Sufficient silicon type insulating compound to fill all the voids in the assembly shall be placed in the housings before installing the pin and the receptacle.

The pin and receptacle connector shall be installed in accordance with the manufacturer's instructions.

At least three (3) feet of slack shall be left for each conductor at each splice.

Ends of spare conductors shall be taped.

Small permanent identification bands shall be marked as detailed in the conductor table following subsection 623.02.07, "Conductors." The bands shall be securely attached to conductors in pull boxes and near the end of each conductor where conductors are terminated. Where circuit and phase are clearly indicated by conductor insulation, bands need not be used.

Permanent identification bands shall be embossed 6 mil, oil resistant polyvinyl chloride tape with pressure-sensitive backing. Tape shall be of a type such that embossed symbols contrast with the background color. Conductors within fixtures or cabinets shall be cabled together with self-clinching nylon cable ties, waxed lacing, or other method approved by the Engineer.

623.03.09 Bonding and Grounding. Metallic cable sheaths, metal conduit, nonmetallic conduit grounding wire, ballast and transformer cases, service equipment, sign switches, anchor bolts, and metal poles and pedestals shall be made mechanically and electrically secure to form a continuous system, and shall be effectively grounded. Bonding and grounding jumpers shall be copper wire or copper strap of the same cross sectional area as No. 6 AWG for series lighting systems and No. 8 AWG for all other systems.

Bonding of standards and pedestals shall be by means of a bonding strap attached to an anchor bolt or a three-sixteenth ($^{3}/_{16}$) inch, or larger, brass or bronze bolt installed in the lower portion of the shaft.

One side of the secondary circuit of series-multiple and step down transformers shall be grounded.

Grounding of metal conduit, service equipment, and neutral conductor at service point shall be accomplished as required by the Code and the serving utility, except that grounding conductors shall be No. 6 AWG, or equal.

For bonding purposes in all nonmetallic type conduit, a

bare No. 6 AWG copper wire shall be run continuously in circuits used for series lighting, and a bare No. 8 AWG copper wire shall be run continuously in all other circuits. In lieu of the continuous copper ground wire, a ground rod, when approved by the Engineer, may be installed at each pole or standard.

Where nonmetallic conduit is to be installed for future conductors, the above mentioned copper wire may be omitted.

At each multiple service point, unless otherwise shown on the plans, a ground electrode shall be furnished and installed. Ground electrodes of steel or iron shall be one-piece lengths of galvanized rod or pipe at least three-fourths (¾) inch in diameter. Electrodes of nonferrous materials, or their approved equivalent, shall be not less than one-half (½) inch in diameter. Ground electrodes shall be installed in accordance with the provisions of the Code. The service equipment shall be bonded to the ground electrode by use of a ground clamp and No. 6 AWG copper wire, enclosed in a one-half (½) inch diameter conduit.

When a ground connection is required in a series lighting system, a plug cutout, as shown on the plans, shall be connected into the circuit and installed in a pull box. The plug shall be grounded to a water pipe or ground electrode.

Where a metal conduit system parallels, or crosses, a permanent water system in accessible areas, grounding jumpers shall be installed at intervals not exceeding five hundred (500) feet.

Ground clamps for service grounding and for grounding of equipment on wood poles shall be a one-half (½) inch galvanized, malleable iron conduit hub with swivel feature.

On wood poles, all equipment mounted less than eight (8) feet above ground surface shall be grounded.

Bonding of metallic conduit in concrete pull boxes shall be by means of galvanized grounding bushings and bonding jumpers.

Bonding of metallic conduit in steel pull boxes shall be by means of locknuts, one inside and one outside of the box.

623.03.10 Service. New service points may be shown on the plans as "approximate location" or "service point not yet established," in which case the Contractor shall determine the exact locations from the serving utility.

At all new and modified service locations the Contractor shall furnish conduit, conductors, and all other necessary material to complete the installation of the service riser.

Where the Contractor is required to install the service on a utility-owned pole, the positioning of the riser and service equipment will be determined by the serving utility.

Service riser conduit shall terminate with a service head or shall be sealed to prevent the entrance of water, as approved by the serving utility.

Where a meter is required, a meter socket, approved by the serving utility, complete with manual circuit closing device and sealing rings shall be furnished and installed.

Service equipment for multiple lighting or traffic signal systems, or both, shall include a two-wire or three-wire solid neutral, fused switch designed to handle the voltages shown on the plans. The switch shall be enclosed in a NEMA Type 3R raintight enclosure which shall be provided with a top hinged cover, hasp for sealing cover, and provisions for locking the handle in the "On" and "Off" positions, and shall be galvanized in conformance with the provisions in subsection 623.02.10, "Galvanizing." The padlock will be furnished by others.

Conduit for multiple lighting or traffic signal service shall not be less than one (1) inch in size. Conduit for series lighting service shall not be less than one and one-half (1½) inches in size.

Each multiple service installation shall be grounded in accordance with the provisions in subsection 623.03.09, "Bonding and Grounding."

A street light bypass switch of 5,000 volt rating shall be connected to control each series lighting circuit. The bypass switch shall be enclosed in a NEMA Type 3R, cutout box of the following sizes: eighteen by ten by six inch (18″ x 10″ x 6″) for one bypass switch and eighteen by twenty-four by six inch (18″ x 24″ x 6″) for two bypass switches.

The cutout box shall be fitted with a cover permanently inscribed "Danger—High Voltage." The cover shall be attached to the box to form a raintight plate and shall require tools for removal. The cutout box shall be installed not less than eight (8) feet above the ground. The cutout box and cover shall be galvanized in accordance with the provisions in subsection 623.02.10, "Galvanizing."

The service pole and all service equipment and wiring on the service pole and the installation thereof shall be considered as included in the contract item of electrical work involved and no additional compensation will be allowed therefor.

Upon request of the Contractor, the Engineer will arrange with the serving utility to complete service connections for both temporary and permanent installations and the Contractor shall pay all required costs and fees therefor.

Upon request of the Contractor, the Engineer will arrange for furnishing electrical energy. Energy used prior to completion of the contract will be charged to the Contractor, except that the cost of energy used for public benefit, when such operation is ordered by the Engineer, will be at the expense of the State or local authorities.

623.03.11 Field Tests. Prior to completion of the work, the Contractor shall cause the following tests to be made on all traffic signal, sign illumination, and lighting circuits, in the presence of the Engineer.

(a) Continuity. Each circuit shall be tested for continuity.

(b) Ground. Each circuit shall be tested for grounds.

(c) Megger. A megger test shall be made on each circuit between the circuit and a ground. The insulation resistance shall not be less than the values specified in the provisions of the Code.

(d) Functional. A functional test shall be made in which it is demonstrated that each and every part of the system functions as specified or intended.

The functional test for each new or modified traffic signal system shall consist of not less than five (5) days of

continuous, satisfactory operation. If unsatisfactory performance of the system develops, the condition shall be corrected and the test shall be repeated until the five (5) days of continuous satisfactory operation is obtained.

The functional test for each highway lighting system and sign illumination system shall consist of an operational test for two consecutive nights according to the regular lighting schedule.

The functional test for each flashing beacon system shall consist of not less than five (5) days of continuous, satisfactory operation.

A continuous two (2) day burning test shall be made on each pedestrian undercrossing lighting system before final acceptance.

Functional tests shall not start on a Friday, or on the day preceding a legal holiday.

Shutdown caused by factors beyond the Contractor's control shall not constitute discontinuity of the functional test.

(e) High Voltage. The Contractor shall perform, on high-voltage series lighting circuits, a high-voltage test consisting of an 8,400 volt, 60 cycle alternating current between the conductors and a ground for five (5) consecutive minutes with the two ends of the circuit connected together. The initially applied voltage shall be applied to the entire completed circuit and shall not be greater than the rated voltage of the cable and the rate of increase shall be approximately uniform and not over one hundred (100) percent in one hundred (100) seconds nor less than one hundred (100) percent in sixty (60) seconds. The voltage shall be increased to the value of 8,400 volts root mean square and held at this value for five (5) minutes.

When approved by the Engineer, the Contractor may, in lieu of the above 8,400 volt test, perform a high-voltage series lighting test consisting of the open circuit voltage of the connected constant current transformer between conductors and ground.

The high-voltage test shall not be performed on existing circuits or equipment. This shall in no way relieve the Contractor from his responsibility for malfunctioning of

existing lighting circuits due to his making splices in or connecting to the circuits, and such malfunctions shall be corrected to the satisfaction of the Engineer.

Any fault in any material or in any part of the installation revealed by these tests shall be replaced or repaired by the Contractor at his expense in a manner approved by the Engineer, and the same test shall be repeated until no fault appears.

623.03.12 Painting. Painting of electrical equipment and materials shall conform to the provisions in Section 614, "Painting," with the following additions and modifications:

Paint materials for electrical installation, unless otherwise specified, shall conform to the provisions in Section 714, "Paints."

Factory or shop cleaning methods for metals will be acceptable if equal to the methods specified herein.

In lieu of the temperature and seasonal restrictions for painting as provided in Section 614, "Painting," paint may be applied to equipment and material for electrical installations at any time approved by the Engineer.

All ferrous surfaces to be painted shall be cleaned as provided in said Section 614, "Painting," prior to applying the vinyl wash primer or prime coat. Blast cleaning of galvanized metal surfaces in good condition, as determined by the Engineer, will not be permitted.

Existing equipment to be painted in the field, including State-furnished equipment, shall be washed with a stiff bristle brush using a solution of water containing two tablespoonsfuls of heavy duty detergent powder per gallon. After rinsing, all surfaces shall be wire brushed with a coarse, cup shaped, power driven brush to remove all poorly bonded paint, rust, scale, corrosion, grease, or dirt. Any dust or residue remaining after wire brushing shall also be removed prior to priming.

Galvanized metal poles and metal guard posts will not require painting.

Two finishing coats of Aluminum Paint, Finish Coat, Section 714, "Paints," shall be applied to the following

nongalvanized equipment: controller cabinets, reused lighting and signal standards, and reused luminaires; and to exterior surfaces and ungalvanized steel edges of raintight enclosures (switches, service, control equipment, transformers, etc.).

Interior of signal hoods, louvers, and front faces of back plates shall be finished with two coats of Enamel; Traffic Signal, Lusterless, Black, as provided in Section 714, "Paints," except that factory enamel finish in good condition will be acceptable.

Painting of outside of signal heads and other signal equipment which have been factory enameled in dark olive green and are in good condition, may be omitted.

Factory finish on new equipment will be acceptable if of proper color and if equal in quality to the specified finish.

Conduit and conduit fittings above ground shall be prepared and finished in the same manner as the adjacent standard or post.

Signal heads, signal head mounting, brackets and fittings, outside of hoods, pedestrian push button housings, pedestrian signal head housings and hoods, and back faces of back plates shall be finished with two coats of Enamel; Traffic Signal, Dark Olive Green, as provided in Section 714, "Paints."

Reused equipment previously finished as specified in subsection 623.02.10, "Galvanizing" shall be given a spot finishing coat on newly primed areas, followed by one finishing coat over the entire surface.

Reused galvanized equipment with extensively rusted areas shall be cleaned and painted as provided for nongalvanized equipment.

Small rusted or repaired areas of reused galvanized equipment shall be cleaned and painted as provided in Section 715, "Galvanizing," for repairing damaged galvanized surfaces.

New galvanized equipment shall not be painted.

All paint coats may be applied either by hand brushing or by approved spraying machines in the hands of skilled operators. The work shall be done in a neat and workmanlike manner. The Engineer reserves the right to require

the use of brushes for the application of paint, should the work done by the paint spraying machine prove unsatisfactory or objectionable, as determined by the Engineer.

623.03.13 Raising or Relocating Existing Pressure-Sensitive Detectors. Raising existing pressure-sensitive detectors to grade shall be accomplished by removing the existing concrete from the detector frame and filling with concrete around the frame at the new grade, unless otherwise specified.

When detectors are to be relocated, either the existing detector contact unit shall be installed in a new frame and foundation, or the existing frame, if in good condition as determined by the Engineer, may be set in a new foundation. The hole left by removing the detector frame shall be filled with concrete.

623.03.14 Salvaging and Reinstalling or Stockpiling Electrical Equipment.

(a) Salvaging Electrical Equipment. Where shown on the plans or ordered by the Engineer, existing electrical equipment, including controllers, cabinets, signal heads, luminaires, standards, mast arms, ballasts, transformers, service equipment, pull boxes, detector frames to be relocated, and detector contact units shall be removed and salvaged.

Care shall be exercised in removing and salvaging electrical equipment so that it will remain in its original form and existing condition whenever possible. Attention is directed to the provisions in subsections 107.11, "Responsibility for Damage Claims" and 107.12, "Protection and Restoration of Property and Landscape." The Contractor will be required to replace, at his expense, any of the above-mentioned electrical equipment, which, as determined by the Engineer, has been damaged or destroyed by reason of his operations.

Unless otherwise specified, underground conduit, conductors, foundations, and detector frames not reused shall become the property of the Contractor and shall be removed from the highway right of way, except if not interfering with other construction, said materials, except

foundations, may, with the written approval of the Engineer, be abandoned in place. Certain other materials, when shown on the plans, shall also become the property of the Contractor.

Attention is directed to the provisions in subsection 623.03.02, "Foundations," regarding foundations to be abandoned.

Holes formed by removing pull boxes and foundations shall be filled with material equivalent to the surrounding material.

(b) Reinstalling Salvaged Electrical Equipment. When salvaged electrical equipment is to be reinstalled, the Contractor shall furnish and install all necessary materials and equipment, including signal mounting brackets, anchor bolts, nuts, washers, and concrete as required to complete the new installation.

All traffic signal, flashing beacon, and lighting fixtures to be reinstalled shall be cleaned and relamped.

Existing materials required to be relocated and found to be unsatisfactory by the Engineer shall be replaced by new material and the cost therefor will be paid for as extra work as provided in subsection 104.03, "Extra Work."

(c) Stockpiling Salvaged Electrical Equipment. Existing equipment removed and not reused shall be salvaged and may be stockpiled at the site of the work.

Hauling and stockpiling of salvaged material off the right of way, as directed by the Engineer, will be paid for as extra work as provided in subsection 104.03, "Extra Work."

METHOD OF MEASUREMENT

623.04.01 Measurement. The unit of measure for "Traffic Signal System," "Highway Lighting System," and "Traffic Signal and Highway Lighting System," will be lump sum.

The quantity of "Conduit for Future Conductors," will be measured for payment by the linear foot of conduit complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

623.05.01 Payment. The lump sum price or prices paid for traffic signal systems, highway lighting systems, sign illumination systems, modifying existing systems, or any combination thereof, shall be full compensation for doing all the work complete and in place as indicated in the contract documents, and as directed by the Engineer, including excavation and backfill, concrete foundations, restoring sidewalk, pavement, and appurtenances damaged or destroyed during construction, salvaging existing materials, and making all required tests.

Full compensation for all additional materials and labor, not shown on the plans or specified, which are necessary to complete the installations of the various systems, shall be considered as included in the prices paid for the systems, or units thereof, and no additional compensation will be allowed therefor, except as provided in subsection 623.01.04, "Maintaining Existing and Temporary Electrical Systems."

The accepted quantities of "Conduit for Future Conductors," measured as provided in subsection 623.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for conduit.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Traffic Signal System	Lump Sum
Highway Lighting System (may include sign lighting system)	Lump Sum
Traffic Signal and Highway Lighting System (may include sign lighting system)	Lump Sum
Conduit for Future Conductors	Linear Foot

SECTION 624

ACCOMMODATIONS FOR PUBLIC TRAFFIC

DESCRIPTION

624.01.01 General. This work shall consist of providing for traffic by constructing detours or special detours, permitting traffic to pass through construction, and using flagmen or pilot cars and maintaining the base, or a combination of these methods as indicated in the contract documents or as directed in writing by the Engineer.

MATERIALS

624.02.01 General. The materials used for the construction and maintenance of facilities required for the free flow of public traffic and for protection of the work shall be those prescribed for the several items which constitute the finished work and shall conform to all the requirements for such materials as set forth herein.

CONSTRUCTION

624.03.01 Special Detours. Special detours shall be constructed as shown on the plans or as specified. Detour locations indicated on the plans may be approximate only; the exact location shall be as staked by the Engineer.

Grading for special detours shall consist largely of motor grader work, supplemented where necessary by other mechanical equipment, to provide the specified roadbed width and a grade line free from breaks or rolls of sufficient magnitude to be hazardous to traffic.

When grading of special detours has been completed and approved by the Engineer and, if required on the plans or in the special provisions, the special detours shall receive surfacing materials of the kind and type specified, and they shall be placed and constructed in accordance with the requirements for the particular materials used.

Water shall be applied to detours in amounts necessary to attain the compaction of graded sections and of surfacing materials.

Maintenance on special detours shall consist largely of filling holes as they develop, adding surfacing and applying liquid asphalt, blading, watering, and performing any other work necessary to maintain the detour satisfactorily, as ordered by the Engineer.

Eradication of special detours shall consist largely of blade grader and scraper work supplemented by other equipment when necessary. Eradication will be performed to the extent that the ground will be restored as nearly as feasible to the original, and material disposed of, all as directed by the Engineer.

624.03.02 Flagmen. If, in the opinion of the Engineer, controlled traffic is necessary for protection of the work or for safety of public traffic, flagmen shall be employed by the Contractor at places designated by the Engineer. This does not exclude the use of flagmen by the Contractor, at his expense, whenever he see fit to do so.

Each flagmen shall be supplied, for use in daylight, with a red shirt or jacket, red cap, and with a red flag not less than eighteen (18) inches square mounted on a staff. Sign paddles may be used in lieu of red flags. They shall be round and not less than fifteen (15) inches in diameter with bold lettering at least five (5) inches in height. A rigidly fixed handle shall be provided. This combination sign may be fabricated from sheet metal or other light semi-rigid material. The background of the "STOP" face shall be red with white letters, and the background of the "GO" face shall be dark green with white letters. If "SLOW" is used the background shall be highway yellow with black letters.

The flagman must stand just outside of approach traffic lane. He should be near enough to the men and work being protected so that there can be no doubt as to his purpose. This distance may vary from two hundred (200) to five hundred (500) feet, depending upon road conditions and upon the visibility and location in regard to curves and hills. The flagman should place himself so that approaching drivers can see him from a distance of at least five hundred (500) feet. He should be positioned so as to have the flag

or sign paddle visible in the traffic lane, but he should not jeopardize his own safety and must be ready to stand clear of an approaching vehicle in case it does not stop.

When signalling traffic to stop, slow down, or proceed, the flagman must face the traffic affected by the signals. The flag or sign paddle is not to be waved. Particular attention must be given to the flagging of traffic when operations are being conducted on a curve or hill and are hidden from the view of an approaching driver.

The flagman should always be courteous but firm, giving explanation in a few words as to the delay or hazard, such as "Men Working in Road Ahead," "Fresh Oil," etc. A flagman must not lose his temper or get into an argument with the traveling public.

In stopping traffic, the flag or paddle shall be extended in a horizontal position across the lane of traffic so that the full area of the flag hanging below the staff is visible.

In slowing down traffic, without stopping, flag or paddle shall be extended in a horizontal position across the lane of traffic and as the vehicle approaches, the flag shall be lowered and traffic motioned to proceed.

To request traffic to proceed after stopping, the flag and arm shall be lowered from the horizontal position and traffic motioned to proceed.

624.03.03 Pilot Cars. If, in the opinion of the Engineer, it is necessary to afford additional protection to the work, workmen, or public traffic, a pilot car and driver shall be used as he directs. This provision shall be in effect even though the pilot car and driver are not indicated on the plans or provided for in these specifications.

Pilot cars shall be suitable vehicles in good mechanical condition and shall carry a sign which shall comply with the design and mounting as shown on the standard drawing appended to the special provisions, or shown on the plans.

624.03.04 Maintain Base. When the proposal contains an item of "Maintain Base," the provisions of subsection 109.03, "Extra and Force Account Work," shall apply.

624.03.05 Equipment Rental. When the proposal contains an item of equipment rental, the use of such equipment shall be as directed by the Engineer or as indicated on the plans.

METHOD OF MEASUREMENT

624.04.01 Measurement. Measurement for the various items involved in accommodating traffic shall be paid for as follows:

(a) When the proposal contains an item "Special Detours," measurement for payment will be made in accordance with the provisions of subsection 109.03, "Extra and Force Account Work."

(b) When the proposal contains an item of "Flagman," the flagging as specified in the contract documents or ordered by the Engineer, will be measured by the number of hours that flagmen are actually used to direct traffic through construction operations, to stop traffic preparatory to piloting operations, and at each point where the Contractor's equipment enters or interferes with the traffic stream.

(c) When the proposal contains the item of "Pilot Car," the piloting as specified in the contract documents or ordered by the Engineer, will be measured by the number of hours that the pilot car and driver are actually used to lead traffic through the controlled areas.

(d) When the proposal contains an item "Maintain Base," measurement for payment will be made in accordance with the provisions of subsection 109.03, "Extra and Force Account Work."

(e) When equipment is used for constructing special detours or maintaining the base and such equipment is rented as indicated in the proposal, it shall be measured for payment by the number of hours actually used.

BASIS OF PAYMENT

624.05.01 Payment. Payment for special detours and maintain base, measured as specified in subsection 624.-04.01, "Measurement," will be paid for by "Force Account."

Eradication of special detours shall be paid for as "Force Account" and shall be included in the bid item "Special Detours."

The accepted quantities of flagmen measured as specified in subsection 624.04.01, "Measurement," will be paid for at the contract bid price per hour for flagmen, which price shall be full compensation for all equipment, competent personnel, and all incidentals necessary for the operation.

The accepted quantities of pilot car, measured as specified in subsection 624.04.01, "Measurement," will be paid for at the contract bid price per hour for pilot car, which price shall be full compensation for the vehicle, an experienced driver, all operating costs, and depreciation.

When the items of flagmen or pilot car do not appear in the proposal, and it is necessary to protect the traveling public, in the Engineer's opinion, flagmen or pilot cars will be furnished by the Contractor and payment therefor will be made in accordance with subsection 104.03, "Extra Work," except, however, when the Contractor constructs and maintains a detour at his expense as provided in subsection 104.04(c), "Maintenance of Traffic."

The accepted quantities of equipment rental measured as specified in subsection 624.04.01, "Measurement," will be paid for at the contract unit price bid per hour for the particular items of equipment indicated in the proposal form. The contract unit price bid per hour shall include skilled operators for each piece of equipment, fuel, lubricants, repairs, depreciation, and all expenses incidental to the operation of the equipment.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Special Detours	Force Account
Flagman	Hour
Pilot Car	Hour
Maintain Base	Force Account
Rent Equipment (type)	Hour

SECTION 625

CONSTRUCTION SIGNS

DESCRIPTION

625.01.01 General. This work shall consist of furnishing and erecting for rental, all necessary barricades, suitable and sufficient flares, warning lights, and standard construction signs at locations set forth in the contract documents, or as directed by the Engineer, for the protection of the work, workmen, and guidance and safety of the traveling public.

All construction signs and barricades shall remain the property of the Contractor upon completion of the contract and shall be removed from the project by him.

MATERIALS

625.02.01 General. It is expressly intended that a rather broad selection of material be granted the Contractor since construction signs are in temporary use. Sign panels may be constructed of steel, aluminum, wood, or other approved material and be of a sound, durable nature. The materials shall be of such quality to do the job for which they are intended and are subject to approval by the Engineer. Signs which have become dull, have flaking or peeling paint, are dirty or are otherwise marred shall be repaired or replaced with acceptable signs.

Sign posts and barricades shall conform to the materials and dimensions shown on the plans.

CONSTRUCTION

625.03.01 General. Signs, barricades, and markings shall conform to the detailed design and methods of erection shown on the standard sheet appended to the contract plans. In situations where messages are required other than those shown, the signs shall conform to the requirements of the M.U.T.C.D. Manual.

All shapes and colors shall be as indicated. All symbols shall be unmistakably similar to those shown, and where a

word message is applicable, the wording shall be as indicated.

Warning signs shall have a background of "highway yellow." Yellow color cards showing the correct "highway yellow" shade for highway signs may be obtained upon request.

Sign dimensions shown are minimum standard. Increases above this minimum are permissible and desirable where investigation has shown a larger sign is needed for adequate emphasis. In the enlarging of signs, standard shapes and colors shall be used, and standard proportions shall be retained, so far as practicable.

All signs and barricades shall be reflectorized unless otherwise specifically noted.

Reflectorization shall be by means of approved reflector "buttons" or similar units set into the symbol or message; or reflecting coatings, either on the sign background or, where a white legend is used on a black or colored background in the symbol or message and border. Reflecting coatings shall consist of glass spheres embedded beneath a flexible transparent plastic which forms a smooth, flat outer surface as exposed in use. Sign reflecting materials shall reflect white light, or if a reflecting coating is used as the background of a colored sign, the color of the background.

Signs must always be placed in positions where they will convey their messages most effectively without restricting lateral clearance of sight distance. Placement must therefore be accommodated to highway design and alignment. Signs must be so placed that the driver will have sufficient time to absorb the message before having to act.

As a general rule, signs shall be located on the right hand side of the roadway, with the near edge of the sign from six (6) feet to twelve (12) feet from the edge of the traveled way or at least two (2) feet outside an unmountable curb. Where construction or maintenance operations are underway, however, it is often necessary to place signs on barricades within the roadway, or (usually as supplementary or duplicate signs) on the left of the roadway. All signs should be mounted approximately at right angles to the direction of and facing the traffic they are to serve. Roadside signs should be mounted so that

the bottom of the sign is approximately five (5) feet above the pavement level. Where construction equipment or materials or other obstructions may be present, this height should be increased to seven (7) feet. Standards for height and lateral clearance of roadside signs are shown in the Standard Drawings. Signs mounted on barricades, or temporary signs in the roadway, may be at lower heights as dictated by circumstances.

Regulatory signs are normally placed at the point where the regulations apply.

Where normal open highway speeds prevail on the approach to the work site, advance warning signs should be placed at least seven hundred fifty (750) feet in advance of the condition to which they are calling attention. Where a series of advance warning signs are used, the warning sign nearest the work site should be placed five hundred (500) feet from the point of restriction with the additional signs at five hundred (500) foot intervals. Where prevailing speeds are low in the approach to the hazardous area, signs may be placed at three hundred (300) foot spacings in the immediate vicinity of the work and at even closer spacings in urban areas. On high-speed expressway-type facilities the advance warning distance shall be increased to one-half (½) mile or more.

Signs in rural areas shall be mounted at a height of not less than five (5) feet above the crown of the pavement to the bottom of the sign, or, where several signs are placed on a single mounting the height shall be four (4) feet to the bottom of the lowest sign. In business and in residential districts, or where parking is likely to occur, or where other obstructions are present, the height shall be at least seven (7) feet to the bottom of the sign.

Before any detour or temporary route is opened to traffic, all necessary signs shall be in place. Signs required by road conditions or restrictions shall be removed immediately when those conditions cease to exist or the restrictions are withdrawn. Guide signs directing traffic to and on temporary routes or detours shall be removed when no longer applicable.

Signs shall be individually erected on separate posts, except where one sign supplements another. Two signs for

different purposes shall not be placed closer together than one hundred (100) feet along the roadway if it can be reasonably avoided.

Signs, posts, and their foundations shall be so constructed as to hold signs rigidly in a proper and permanent position, and prevent them from swaying in the wind, or from being turned or otherwise displaced by children or irresponsible persons.

A portable or removable type of mounting may be used for signs required intermittently or which are frequently moved. Such a mounting shall be heavy enough not to turn over in the wind, and its base shall not be appreciably wider than the sign.

Highways closed to traffic shall be protected by Class III barricades on which shall be placed appropriate warning signs. The Contractor shall provide and maintain appropriate warning and detour signs at all closures, intersections, and along detour routes, directing the traffic around the closed portions of the highway so that the temporary detour route or routes shall be indicated clearly throughout its or their entire length. All barricades, signs, and obstructions shall be illuminated at night, and all lights for this purpose shall be kept burning from sunset to sunrise. All lighting shall conform to the M.U.T.C.D. Manual.

Signs and barricades shall be maintained in first-class condition and any which may become scarred or damaged or destroyed shall be repaired immediately or replaced, at the Contractor's expense, as directed by the Engineer.

The responsibility for the protection of the work, workmen, and public traffic will rest with the Contractor and he shall be liable for damages and injury suffered by reason of the Contractor's operations or any circumstances, conditions, actions, or negligence in connection therewith.

METHOD OF MEASUREMENT

625.04.01 Measurement. The quantity of construction signs to be measured for rental will be the number of square feet of sign surface furnished in accordance with the dimensions shown on the plans.

Barricades will be measured for rental as units and will

be identified by the class set forth in the proposal. If more than one class of barricade is involved, separate measurement will be made of each class given. For purposes of measurement and rental, Class I barricades will be four (4) feet to seven (7) feet eight (8) inches inclusive, Class 2 barricades will be eight (8) feet to eleven (11) feet eight (8) inches inclusive, Class 3 barricades will be twelve (12) feet and up. Measurements will be made in the completed work according to the dimensions shown on the plans.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

625.05.01 Payment. The accepted quantity of construction signs measured as provided in subsection 625.04.01, "Measurement," will be paid for at the contract unit price bid per square foot.

The accepted quantity of barricades measured as provided in subsection 625.04.01, "Measurement," will be paid for at the contract unit price bid per each for the class specified.

Moving signs and barricades from one location to another on the project, as directed by the Engineer, shall be considered necessary and essential and no additional compensation will be allowed therefor.

The above prices shall be full compensation for furnishing, erecting, maintaining, moving, removing, and disposing of signs and barricades and any necessary excavation and backfill and for furnishing warning lights, flares, and hardware necessary to complete the work.

Partial payments may be made as set forth under subsection 109.06, "Partial Payments."

Signs and barricades which have been approved for payment shall not be removed from the project until approved in writing by the Engineer.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Rent Construction Signs	Square Foot
Rent Construction Barricades (class)	Each

SECTION 626

TEMPORARY SIGNS

DESCRIPTION

626.01.01 General. This work shall consist of furnishing and erecting new signs or barricades, or erecting previously removed signs or barricades at locations shown in the contract documents or directed by the Engineer, for the safety of the traveling public at temporary connections.

MATERIALS

626.02.01 General. Material for sign panels shall conform to the applicable requirements of Section 716, "Sign Materials."

Sign posts shall be timber of the size shown on the plans. The posts shall be of the same materials, receive the same preservative treatment, and be painted as required under Section 620, "Right of Way Markers."

CONSTRUCTION

626.03.01 General. Signs, barricades, and markings shall conform to the detailed design and methods of erection shown on the standard sheet appended to the contract plans. In situations where messages are required other than those shown, the signs shall conform to the requirements of the M.U.T.C.D. Manual.

Signs mounted on posts shall be braced with one and one-half by one and one-half by one-eighth inch (1½″ x 1½″ x ⅛″) galvanized angle iron placed flat against the back of the sign and as follows:

Rectangular signs four (4) feet or more in width shall have two angle iron braces placed horizontally a distance one-fourth the vertical dimension of the sign from the top and the bottom. Four by four foot (4′ x 4′) diamond shape signs shall have one angle iron brace placed horizontally from corner to corner. Posts shall be notched to accommodate angle iron braces. The galvanized angle iron shall be bolted to the post and sign face with three-eighths (⅜)

inch galvanized bolts with hexagon heads and nuts; each bolt shall have two galvanized flat washers and one galvanized lock washer. Bolts shall be placed through the post and three (3) inches from each end of the angle iron.

626.03.02 Preparation of Sign Faces. The requirements of this subsection shall be the same as prescribed in subsection 627.03.02, "Preparation of Sign Faces."

626.03.03 Sign Background. The requirements of this subsection shall be the same as prescribed in subsection 627.03.03, "Sign Background."

626.03.04 Cut-out Letters, Numerals, Symbols, and Accessories. Letters and numerals shall conform to Standard Alphabets of the Bureau of Public Roads. Tables can be obtained from the Bureau of Public Roads.

Reflectorized letters, numerals, symbols, and borders shall be cut from reflectorized sheeting and shall be as follows:

(a) On signs larger than four by six feet (4′ x 6′) they shall be applied to cut-out aluminum backing by a process recommended by the manufacturer, shall be demountable and shall be applied to the sign background with screws or rivets of the type recommended by the manufacturer. Aluminum alloy sheeting for backing shall be No. 14 B & S gage (.064 inch) (Increment Sheets).

All shop cutting, drilling, punching, or working of the aluminum shall be done prior to cleaning, etching, and treating, as hereinafter provided, and all work shall be done in a workmanlike manner to provide letters and symbols of uniformly neat appearance without rough edges or burrs. The aluminum backing material shall be degreased and etched in the same manner as specified for the preparation of sign faces for the application of reflective sheeting.

(b) On signs of four by six foot (4′ x 6′) size or less, they shall be applied directly to the surface of the background by a process recommended by the manufacturer. Letters shall not be spliced.

Silver reflectorized sheeting with a minimum brightness

one hundred eighty (180) percent of that specified above shall be applied to the cut-out letters, numerals, symbols, and borders of the aluminum backing mechanically by use of the vacuum applicator process as specified by the manufacturer.

The reflectorized sheeting material when applied as prescribed, shall adhere to the metal surface under conditions of normal use, including twenty-four (24) hours of soaking in water at seventy-five (75) degrees Fahrenheit, and shall withstand accelerated weathering tests for the equivalent of three (3) years of normal weathering without excessive bead loss, discoloration, or loss in reflection.

626.03.05 Installation. Sign locations indicated on the plans are approximate only. Final determination of sign locations will be made in the field by the Engineer.

Each sign face shall be thoroughly cleaned according to the reflective material manufacturer's recommendations, and all undesirable material that is visible on the face of the sign shall be removed. The use of abrasives or other cleaning material that will scratch or otherwise deface shall not be permitted.

Sign faces of all directional signs facing public traffic and directing such traffic to a portion of the project not yet open to public traffic, shall have the message covered.

Care shall be exercised at all times in handling, storing, transporting, and erecting of the signs. Signs which are damaged shall be repaired or replaced at the Contractor's expense.

626.03.06 Tests. It shall be the Contractor's responsibility to ascertain that all required tests have been made by qualified testing laboratories as approved by the Engineer. The Contractor shall furnish the Engineer with a written certification that all required tests have been satisfactorily completed and that materials and fabrication thereof comply with all requirements.

626.03.07 Remove and Re-erect Temporary Signs or Barricades. Signs or barricades to be removed and re-erected will be designated on the plans or in the Special

Provisions. Care shall be taken in removing signs or barricades and no equipment or devices shall be used which might cause damage thereto. If damage is done due to the negligence of the Contractor, the sign shall be replaced in kind at the expense of the Contractor.

Any new posts or hardware necessary to re-erect the sign or barricade shall be furnished by the Contractor, shall be of the same kind as those in the original, if available, and the cost thereof shall be included in the contract price for the work. The Department reserves the right to furnish the Contractor with such materials as it deems advisable, and these materials shall be used in the re-erection of the signs or barricades in lieu of materials removed.

Sign and barricade reflectorized faces shall be cleaned in accordance with the provisions of subsection 626.03.05, "Installation."

METHOD OF MEASUREMENT

626.04.01 Measurement. The quantity of new or re-erected temporary signs to be measured for payment will be the number of square feet of sign surface in the completed work measured in accordance with the dimensions shown on the plans.

New or re-erected barricades will be measured for payment as units and will be identified by the class set forth in the proposal. If more than one class of barricade is involved, separate measurement will be made of each class given. For purposes of measurement and payment, Class 1 barricades will be four (4) feet to seven (7) feet eight (8) inches inclusive, Class 2 will be eight (8) feet to eleven (11) feet, eight (8) inches inclusive, and Class 3 barricades will be twelve (12) feet and up. Measurements will be made of the completed work according to the dimensions shown on the plans.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

626.05.01 Payment. The accepted quantity of new and re-erected temporary signs measured as provided in

subsection 626.04.01, "Measurement," will be paid for at the contract unit price bid per square foot.

The accepted quantity of barricades measured as provided in subsection 626.04.01, "Measurement," will be paid for at the contract unit price bid per each for the types and sizes specified.

The above prices shall be full compensation for erecting, removing and re-erecting, excavation and backfill, and for all materials and labor necessary to complete the work.

Partial payments for new signs and barricades may be made as set forth under subsection 109.06, "Partial Payments."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Temporary Signs	Square Foot
Temporary Barricades (Class .....)	Each
Temporary Signs Remove and Reset	Square Foot

SECTION 627

PERMANENT SIGNS

DESCRIPTION

627.01.01 General. This work shall consist of furnishing, erecting, and installing all signs, sign supports, and other material required for highway signs in accordance with AASHO manuals, "Signing and Pavement Marking of the National System of Interstate and Defense Highways" and the M.U.T.C.D. Manual, these specifications as shown on the plans and as directed by the Engineer. This item **does not** include construction signs used for traffic control during construction or temporary signs used for temporary connections.

MATERIALS

627.02.01 General. All materials shall conform to the requirements specified in the following sections:

Portland Cement Concrete	Section 501
Reinforcing Steel	Section 505
Sign Materials	Section 716

CONSTRUCTION

627.03.01 Fabrication. Fabrication shall be as follows:

(a) Aluminum Sheet Panel. Sign panel sections shall be fabricated of standard width aluminum sheets not less than four (4) feet wide, except that not more than two (2) sheets for any one sign may be cut to less than four (4) feet in total width. Panel sections shall run from the top edge to the bottom edge of the sign without horizontal joints.

The panel sections shall be provided with suitable fastenings, as shown on the plans, to permit easy attachment to the supporting frames. These fastenings shall be so designed as to carry the full design load with a factor of safety of not less than 1.5. Panel sections shall be provided with closure strips at the joints.

Closure strip shall be anchored by aluminum rivets as shown on the plans. Rivets shall be the same color as the sign face.

(b) Laminated Panel. Sizes of completed panel shall be as indicated on the plans; care shall be taken to minimize need for message material to lie across any joint between sheets.

The perimeter frame around all sheets shall be one by one by one-sixteenth inch (1″ x 1″ x $\frac{1}{16}$″) plus .000 inch minus .024 inch No. 6063–T6 extruded aluminum channel, and shall conform to ASTM B221, mitered and heliarc welded at the corners to seal against moisture penetration. A one by one by one-sixteenth inch (1″ x 1″ x $\frac{1}{16}$″) plus .000 inch minus .024 inch No. 6063–T6 square extruded aluminum tubing shall be heliarc welded to the perimeter frame where the laminated panel is attached to the supports as shown on the plans.

The laminating adhesive shall be of the thermoplastic neoprene rubber base solvent type exhibiting a resilient oil and water resistance bond. The solids content shall be suitable for automatic spray application and yield a dry weight of adhesive of 4.5 grams per square foot minimum. A uniform film (scotch grain appearance) of adhesive shall be applied by automatic spray application to each surface and force dried at a temperature of one hundred eighty (180) degrees Fahrenheit minimum using sufficient pressure to insure intimate mating of the surfaces.

At each corner, on the face and back of every panel, two (2) self-plugging rivets shall be used to secure the sheets to the perimeter frame.

All units shall be flat, within measured plus or minus .040 inch per foot across the plane of each panel from opposite corners. All perimeter edges shall be routed flush and smooth. Edges shall be straight, within a plus or minus one-sixteenth ($\frac{1}{16}$) inch.

On multiple panel signs, the seam closure strips between panels shall be provided by the manufacturer and installed by the Contractor. Strips shall be of .025 inch 6061 aluminum sheet. Strips shall be two (2) inches wide with the finish to match the backs of the laminated panel. Holes in closure strips shall be seven thirty-seconds ($\frac{7}{32}$) inch in

diameter spaces as shown on the plans. Closure strips shall be riveted with self-plugging blind aluminum rivets with a three-sixteenths (3/16) inch minimum diameter and a one-fourth (1/4) inch minimum grip range.

The mounting holes in the laminated sheets shall be drilled by the manufacturer. Hardware and mounting details shall be as shown on the plans.

Suppliers shall furnish certification that these materials meet the requirements of the specifications as set forth above.

All work shall be performed in a neat, workmanlike manner. Materials shall be carefully handled to prevent marring or warping. If necessary to drive sheets, a soft hammer or wooden block shall be used.

(c) Supporting Frame. The frame supporting the sign shall consist of horizontal Z section members with vertical tubular stiffeners. The stiffeners shall be provided with expansion assemblies as shown on the plans, and the bolted connections shall be made with Z section members through bolt holes in the neutral axis of the Z section web.

Field drilling of holes in any part of the structural assembly will not be permitted.

(d) Fastening to Posts. The post clamp shall be securely clamped to the wide flange beam and bolted to the Z sections as shown on the plans.

(e) Shop Drawings. Before fabrication is started, shop drawings shall be prepared and submitted to the Engineer.

627.03.02 Preparation of Sign Faces. All sign faces shall be made of sheet aluminum. The aluminum shall be free of all corrosion, white rust, and dirt. All sign dimensions, metal gage, and bolt holes shall conform to the requirements set forth on the plans and in these specifications. Metal degreasing will be required on all sheet aluminum and shall be performed by one of the following methods:

(a) Vapor degreasing. Signs shall be completely immersed in a saturated vapor of trichlorethylene or perchlorethylene. Trade mark printing shall be removed with lacquer thinner or a controlled alkaline cleaning system, and rinsed thoroughly with running water.

(b) Alkaline degreasing. Signs shall be completely immersed in a tank containing alkaline solutions controlled and titrated to the solution manufacturer's specification. Immersion time shall depend upon the amount of soil to be removed. Signs shall then be thoroughly rinsed with running water.

Whenever reflective sheeting is required on the sign, the aluminum shall be etched by one of the following methods:

1. Acid etch. The aluminum shall be well-etched in a six (6) to eight (8) percent phosphoric acid solution at one hundred (100) degrees Fahrenheit and rinsed thoroughly with running cold water, followed with a hot water tank rinse.

2. Alkaline etch. Etch well the pre-cleaned aluminum in an alkaline etching material that is controlled by titration. Time, temperature, and concentration shall be as specified by the solution manufacturer. Smut shall be removed with an acidic, chromium compound type solution as specified by the solution manufacturer and the sign then rinsed thoroughly.

3. The surface etch shall provide a clean, mat, nonshine or non-glare finish suitable for the application of paint or sheeting and for the unpainted back or reverse side of highway signs.

After the degreasing and etching process, the aluminum shall be dried by use of a forced air drier.

Metal shall not be handled, except by device or clean canvas gloves between all cleaning operations and the application of the sign background material. There shall be no opportunity for the aluminum to come in contact with greases, oils, or other contaminants prior to the application of the background material.

Fabrication of all metal parts shall be accomplished in a uniform and workmanlike manner. All fabrication, including cutting, shall be completed prior to the cleaning process. Metal panels shall be cut to size and shape and shall be free of buckles, warp, dents, cockles, burrs, and other defects resulting from fabrication. The surface of all sign panels shall be a plane surface.

627.03.03 Sign Background. The color of the sign background material, as well as the color of the letter, will be specified on the plans. The colors provided shall conform and match as nearly as possible the colors described in the M.U.T.C.D. manual, and the "Manual for Signing and Pavement Marking of the National System of Interstate and Defense Highways." Any variance of these colors must be approved by the Engineer before they may be used.

The following specifications shall apply for reflectorized background of signs:

Reflective sheeting shall consist of glass spheres embedded within a flexible transparent plastic which forms a smooth, flat outer surface as exposed in use. The backing to which the glass spheres are adhered shall consist of synthetic sheet resins or other suitable noncellulosic material. Reflective sheeting shall include a pre-coated adhesive on the back which shall be activated with heat or solvent, without the necessity of additional adhesive coats on the reflective sheeting or application surface.

The pre-coated adhesive shall form a durable bond to the aluminum panels. The pre-coated adhesive, after forty-eight (48) hours of aging at seventy-five (75) degrees Fahrenheit from the time of application, shall be strong enough to resist peeling the reflective sheeting from the application surface, tough enough to resist scuffing and marring during normal handling, elastic enough at low temperatures to resist shocking off when struck, and moisture resistant enough to withstand eight (8) hours of soaking in water at seventy-five (75) degrees Fahrenheit, without appreciable decrease in adhesion. The pre-coated adhesive shall have no staining effect on the reflective sheeting and must be mildew resistant.

Reflective sheeting for background and direct or reversed screened signs shall have the following minimum brightness values at two-tenths (.2) degrees and five-tenths (.5) degrees divergence, expressed in units of candle power per foot candle per square foot of material:

Divergence	Silver White		Yellow		Red		Blue		Green	
Angle	.2	.5	.2	.5	.2	.5	.2	.5	.2	.5
Angle of Incidence—										
0 degrees	40	17	25	8	10	5	5	2	5	3
30 degrees	20	10	10	4	5	2	2.2	1.0	2.2	1.0

The brightness of the reflective sheeting, totally wet by rain, shall not be less than ninety (90) percent of the values specified above.

The reflective sheeting shall be carefully matched for color at the time of sign fabrication to provide uniform appearance and brilliance both day and night. Alternate, successive width sections of sheeting must be reversed and consecutive to insure that corresponding edges of reflective sheeting lie adjacent on the finished sign. Non-conformance may result in non-uniform shading and an undesirable contrast between adjacent widths of applied sheeting which will not be acceptable. Reflective sheeting shall be furnished in one hundred fifty (150) foot rolls and be free from ragged edges, cracks, scale, and blisters.

Reflective sheeting shall be moisture resistant and readily cut with scissors, knife blade, or shears without cracking, crazing, checking, or flaking.

Reflective sheeting shall be applied by the continuous roller method or by vacuum applications in a manner recommended by the manufacturer of the sheeting.

Following the screening of the background, message and border, and the application of the face or following the application of cut-out sheeting copy, the sign face and edges shall be coated with a full, glossy coat of finishing clear as supplied by the manufacturer of the reflective sheeting. Clear finish coats may be applied by either spraying, roll coating, or silk screen process. The thickness of the clear coating after drying shall be a minimum of 0.50 mil.

Each coat of paint shall be thoroughly dry before succeeding coats are applied and before packaging.

627.03.04 Cut-out Letters, Numerals, Symbols, and Accessories. All names of places and highways on guide signs shall be composed of lowercase letters with initial

capital letters. The initial capital letters shall be one and one-third times the "loop" height of the lowercase letters. Other legend on guide signs shall be in capital letters.

A suitable design for the lowercase alphabet is available to highway departments and sign manufacturers from the U.S. Bureau of Public Roads. It is intended that the initial capital letters (and numerals) used with this alphabet will be series E of the Standard Alphabets for Highway Signs (available from the Bureau) modified by widening the stroke-width to approximately one-fifth the letter (or numeral) height. Tables of recommended letter spacing can also be obtained from the Bureau of Public Roads.

Arrows which are used for the large directional signs shall be in direct proportion to the arrows shown in the "Manual for Signing and Pavement Marking of the National System of Interstate and Defense Highways."

Reflectorized letters, numerals, symbols, and borders shall be cut from reflectorized sheeting and shall be as follows:

(a) On signs larger than four by six feet (4′ x 6′) they shall be applied to cut-out aluminum backing by a process recommended by the manufacturer, shall be demountable and shall be applied to the sign background with screws or rivets of the type recommended by the manufacturer. Aluminum alloy sheeting for backing shall be No. 14 B & S gage (.064 inch) (Increment Sheets).

All shop cutting, drilling, punching, or working of the aluminum shall be done prior to cleaning, etching, and treating, as hereinafter provided, and all work shall be done in a workmanlike manner to provide letters and symbols of uniformly neat appearance without rough edges or burrs. The aluminum backing material shall be degreased and etched in the same manner as specified for the preparation of sign faces for the application of reflective sheeting.

(b) On signs of four by six foot (4′ x 6′) size or less, they shall be applied directly to the surface of the background by a process recommended by the manufacturer. Letters shall not be spliced.

Silver reflectorized sheeting with a minimum brightness

one hundred eighty (180) percent of that specified above shall be applied to the cut-out letters, numerals, symbols, and borders of the aluminum backing mechanically by the use of the vacuum applicator process as specified by the manufacturer.

The reflectorized sheeting material when applied as prescribed, shall adhere to the metal surface under conditions of normal use, including twenty-four (24) hours of soaking in water at seventy-five (75) degrees Fahrenheit, and shall withstand accelerated weathering tests for the equivalent of three (3) years of normal weathering without excessive bead loss, discoloration, or loss in reflection.

627.03.05 Installation. Sign locations indicated on the plans are approximate only. Final determination of sign locations will be made in the field by the Engineer.

Signs and sign islands shall be constructed to the lines and grades given by the Engineer and in accordance with the design and locations shown on the plans.

All signs shall be erected as specified before, during or immediately after the completion of bituminous plantmix surface operations.

The date of installation, consisting of month and year, shall be permanently stamped on the back of each sign with metal dies and shall be visible only on close inspection. The stamp shall be placed on the lower right hand corner when facing the rear of the sign.

Each sign face shall be thoroughly cleaned according to the reflective material manufacturer's recommendations, and all undesirable material that is visible on the face of the sign shall be removed. The use of abrasives or other cleaning material that will scratch or otherwise deface shall not be permitted.

Sign islands shall be constructed as roadway embankment in conformity with Section 203, "Excavation and Embankment." Structure excavation and backfill shall conform to the requirements of Section 206, "Structure Excavation" and Section 207, "Backfill." Anchor bolts shall be set true to line and grade and posts shall be plumb.

Sign faces of all directional signs facing public traffic

and directing such traffic to a portion of the project not yet open to public traffic, shall have the message covered.

Care shall be exercised at all times in the handling, storing, transporting, and erecting of the signs. Signs which are damaged shall be repaired or replaced at the Contractor's expense.

627.03.06 Tests. It shall be the Contractor's responsibility to ascertain that all required tests have been made by qualified testing laboratories as approved by the Department. The Contractor shall furnish the Department with a written certification that all required tests have been satisfactorily completed and that materials and fabrication thereof comply with all the requirements.

METHOD OF MEASUREMENT

627.04.01 Measurement. The quantity of permanent signs to be measured for payment will be the number of square feet of sign surface. Measurement to be the dimensions shown on the plans for the work complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

627.05.01 Payment. The accepted quantity of permanent signs, measured as provided in subsection 627.04.01, "Measurement," will be paid for at the contract unit price bid per square foot.

The price per square foot shall include any necessary excavation, embankment, backfill, concrete, reinforcing steel, and all materials and work involved in erecting permanent signs.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Permanent signs	Square Foot

DIVISION III

MATERIALS DETAILS

SECTION 701

PORTLAND CEMENT

SCOPE

701.01.01 Materials Covered. This specification covers the five types of Portland cement as required under pertinent sections of these specifications. Unless otherwise provided, Type II, "low alkali cement," shall be used for all Portland cement concrete, mortar, cement-treated base, and cement-treated subgrade.

PHYSICAL PROPERTIES AND TESTS

701.03.01 Requirements. The cements, except Type II cement, shall meet the requirements set out in the current Standard Specifications for Portland Cement, AASHO Designation M85.

Type II cement shall conform to the specifications of ASTM Designation C150 with the following exceptions:

(a) The cement shall not contain more than 0.60 percent by weight of alkalies calculated as Na_2O plus 0.658 K_2O when determined by flame photometry, using the direct intensity method in the specifications of ASTM Designation C114.

(b) The percentage of tricalcium silicate shall not be limited.

SECTION 702

CONCRETE CURING MATERIALS AND ADMIXTURES

SCOPE

702.01.01 Materials Covered. This specification covers concrete curing materials, subgrade paper, air-entraining admixtures, water retardants, calcium chloride, and hydrated lime. Attention is directed to Section 722, "Water" for mixing and curing.

PHYSICAL PROPERTIES AND TESTS

702.03.01 Curing Materials. Curing materials shall conform to the requirements of the following tests:

Cotton Mats for Curing Concrete	AASHO M73
Burlap Cloth made from Jute or Kenaf	AASHO M182
Waterproof Paper for Curing Concrete	AASHO M139
Liquid Membrane-Forming Compounds for Curing Concrete	Nev. T481*
Plastic Sheeting	Nev. T482
Pigmented Curing Compound for Portland Cement Pavement	Nev. T481**
White Polyethylene Sheeting (film) for Curing Concrete	Nev. T482

*Except: (a) The curing compound shall not react harmfully with the components of concrete or contain oils, waxes, or other materials which would prevent bonding of traffic marking paints. In order to obtain proper bond between the concrete and joint fillers, the Contractor will be required to carry on his operations in a manner which will insure that joint recesses are free of the compound at the time the joint material is placed. The film of curing compound shall be continuous, uniform, and free from pinholes, bubbles, or blisters.

(b) The curing compound shall be clear or translucent and contain a fugitive dye to assist in securing uniform coverage. The color shall remain visible for at least one (1) hour after application. The color of the fugitive dye shall disappear within seven (7) days after application.

(c) The curing compound shall be of such viscosity that it may be readily applied by approved pressure spraying equipment at temperatures above forty (40) degrees Fahrenheit.

(d) When applied by pressure spray to the troweled surface of a vertical, damp concrete specimen, one (1) foot square, at the rate of two hundred (200) square feet per gallon, the curing compound shall adhere to the surface in a continuous, tenacious film without running off or appreciable sagging. In spraying the specimen the nozzle of the spray shall be held between four (4) and six (6) inches from the surface of the specimen.

(e) The membrane shall not peel; it shall disappear from the surface by gradual disintegration from exposure to the elements over a period of not less than thirty (30) days nor more than one (1) year, leaving the concrete hard and without discoloration.

(f) Curing material shall be supplied only in clean containers that are in good condition. It shall be delivered to the job in the manufacturer's original container, which shall be clearly marked with the manufacturer's name, trade

702.03.02 Subgrade Paper. Subgrade paper shall conform to the requirements of AASHO M74.

702.03.03 Air-Entraining Admixtures. Air-entraining admixtures shall conform to the requirements of Test Method No. Nev. T429.

702.03.04 Admixtures Other Than Air-Entraining. These admixtures shall be tested by Test Method No. Nev. T467. The concrete so tested and containing admixtures, shall not exceed a change in length of one hundred forty (140) percent of the control.

702.03.05 Calcium Chloride. Calcium chloride shall conform to the requirements of Test Method No. Nev. T562.

702.03.06 Hydrated Lime. Hydrated lime shall conform to the requirements of ASTM C207, Type N.

---

name of the material, and batch number or symbol by which samples submitted for testing purposes may be identified.

(g) All curing compounds not previously approved shall be tested by a reputable testing laboratory, recognized by the State, who shall certify that the curing compound meets these specifications and requirements. The Contractor shall furnish the Department with this certification prior to using the curing compound.

**Except the loss of water in the water retention test shall not exceed 0.040 gram per square centimeter of surface.

SECTION 703

BITUMINOUS MATERIALS

SCOPE

703.01.01 Materials Covered. This specification covers the quality of asphalt cement, liquid asphalt, emulsified asphalt, cationic emulsion, and asphalt for waterproofing and dampproofing.

REQUIREMENTS

703.02.01 Contractor's Responsibility. Bituminous material failing the requirements (including tolerances) of the tests hereinafter prescribed shall be subject to the provisions of subsection 109.02, "Scope of Payment," and attention is directed thereto.

703.02.02 Shipping Notice. When shipment of materials arrive on the project after normal working hours, the Contractor shall notify the Engineer sufficiently in advance to make arrangements for an inspector to be present when the material is sampled.

Shipping notices shall be mailed upon making shipment and shall contain the following information:

(a) Consignee and destination.
(b) State contract number.
(c) Delivery point.
(d) Date shipped.
(e) Car initial and number of truck transport delivery ticket number.
(f) Type and grade of material.
(g) Quantity loaded.
(h) Loading temperature.
(i) Net quantity.
(j) Signature of shipper or authorized representative.

One copy of the shipping notice shall be mailed to the State Highway Engineer at Carson City, Nevada, and two copies to the Resident Engineer of the project to which shipment is made.

PHYSICAL PROPERTIES AND TESTS

703.03.01 Refinery Test Report. Refinery test reports shall be mailed to the Resident Engineer as soon as tests have been completed, and the reports shall contain the following data:

(a) Date of shipment.
(b) Car initials and number of truck transport delivery ticket number.
(c) Destination and consignee.
(d) State contract number (or State purchase order number, if applicable).
(e) Type and grade of material.
(f) Certificate of grade (certify that material conforms to these specifications, and itemize results on tests performed and date of test).
(g) Signature of refinery's authorized representative.

The certificate of compliance shall be used as a basis for permitting immediate use of the material on the job and shall represent conditional acceptance only.

703.03.02 Asphalt Cements. Asphalt cement shall be prepared by the distillation of crude petroleum. This asphalt shall be homogeneous, free from water, and shall not foam when heated to three hundred forty-seven (347) degrees Fahrenheit.

These specifications cover the following penetration grades: 40–50, 60–70, 85–100, 120–150, 200–300.

The various penetration grades set forth above shall conform to the requirements and the methods of testing shall be as shown in Table I.

TABLE I—Specifications for Asphalt Cement Road Materials

Test	Nev. Test Method	Grade; Requirements 40–50	60–70	85–100	120–150	200–300	Allowable Tolerance
*Flash Point (P.M.C.T. °F. Min.)	T714	460	450	440	425	400	15°F. below
*Flash Point (C.O.C. °F. Min.)	T716	460	450	440	425	400	15°F. below
Penetration of Bituminous Matls. (original sample at 77°F.)	T717	40–50	60–70	85–100	120–150	200–300	4 Percent**
Thin Film Oven Test (loss on heating, 5 hr. at 325°F., percent max.)	T718****	0.75	0.80	0.85	1.00	1.50	20 Percent**
Rolling Thin Film Oven Test	T728****	0.75	0.80	0.85	1.00	1.50	20 Percent**
Penetration of Bituminous Matls. (pen. after loss at 325°F., percent of orig. pen., min.)	T717	52	50	47	44	40	4 Percent**
Ductility of Bituminous Matls. (Ductility at 77°F., cm. after loss at 325°F., min.)	T720	50	50	75	75	75	None

Penetration of Bituminous Matls. (penetration ratio) Pen. 39.2°F. —200 gm. —1 Min. / Pen. 77°F. —100 gm. —5 secs. x 100	T717	25 min.	25 min.	25 min.	25 min.	25 min.	None
Saybolt Viscosity (furol viscosity at 275°F.)	T721	120–430	100–325	85–260	70–210	50–150	None
Proportion of Bitumen Soluble in Carbon Tetrachloride (percent min.)	T710	99	99	99	99	99	.13 Percent below Min.
Spot Test of Asphaltic Matls. (heptane xylene equiv., percent max.)	T726***	35	35	35	35	35	.....

*In case of off-grade asphalt as determined by Test Method No. Nev. T716, Test Method No. Nev. T714 shall be used as an alternate test. When both T716 and T714 Test Methods show failing results, the material shall be subject to liquidated damages as hereinafter described.

**When tolerances are expressed in terms of percent, the allowable deviation is calculated as the indicated percentage of the upper or lower specification limit, whichever is applicable.

***Normal spot test and glass plate test repeated at end of twenty-four (24) hour period will not be required.

****Either Test Method T718 or T728 may be used for loss on heat. Method to be determined by the Engineer.

Asphalt cement not conforming to the requirements of Table I will be assessed demerits in accordance with the graduated increments of the following schedule. Attention is directed to subsection 109.02, "Scope of Payment," where demerits will be evaluated for damages sustained by reason of any noncompliance.

Test Method	Increment	Demerits (each increment of noncompliance)
Nev. T714	*	3
Nev. T716	*	3
Nev. T717	0.2 millimeter above max.	1
	1.0 millimeter below min.	1
Nev. T718 or T728	0.5 percent above max.	5
Nev. T717	0.1 millimeter above max. or below min.	2
Nev. T720	5 centimeters below min.	2
Nev. T717	2 percent below min.	1
Nev. T721	1 sec. below min. or above max.	1
Nev. T710	0.01 percent below min.	1
Nev. T726	5 percent above max.	1

*Material that flashes below the minimum requirements will be assessed three demerits without regard to the number of degrees below minimum.

703.03.03 Liquid Asphalts. Liquid asphalts shall consist of materials conforming to the following classifications. Rapid curing products, designated by the letters RC, shall consist of paving asphalt with a penetration of approximately 85 to 100 fluxed or blended with a naphtha solvent. Medium curing products, designated by the letters MC, shall consist of paving asphalt fluxed or blended with a kerosene solvent. Slow curing products, designated by the letters SC, shall consist of natural crude oils or residual oils from crude asphaltic petroleum. When tested in accordance with the standard methods of Nevada, the grades of liquid asphalt shall conform to the requirements specified in the tables set forth below:

TABLE II—Rapid Curing Products

Test	Nev. Test Method	Grade; Requirements RC–70	RC–250	RC–800	RC–3000	Allowable Tolerances
Flash Point (C.O.C.) °F., Min.	T716	.....	80	80	80	15°F. below
Kinematic Viscosity at 140°F., CS.	T705	70–140	250–500	800–1600	3000–6000	1.5 Percent*
Distillation	T706	.....	.....	.....	.....	.....
Distillate (percent of total distillate to 680°F.)						
to 374°F., Min.		10+	.....	.....	.....	1.0
to 437°F., Min.		50+	35+	15+	.....	1.0
to 500°F., Min.		70+	60+	45+	25+	1.0
to 600°F., Min.		85+	80+	75+	70+	1.0
Residue from Distillation to 680°F. Volume Percent of Sample by Difference, Min.		55+	65+	75+	80+	1.0
Tests on Residue from Distillation						
Penetration 77°F. 0.1 mm	T717	80–120	80–120	80–120	80–120	8 Percent*
Ductility 77°F., cm. Min.	T720	100+	100+	100+	100+	None
Solubility in CCl_4, Percent Min.	T710	99.5+	99.5+	99.5+	99.5+	.13 Percent below Min.

*When tolerances are expressed in terms of percent, the allowable deviation is calculated as the indicated percentage at the upper or lower specification limit, whichever is applicable.

TABLE III—Medium Curing Products

Test	Nev. Test Method	Grade; Requirements MC–70	MC–250	MC–800	MC–3000	Allowable Tolerances
Flash Point (C.O.C.) °F., Min.	T716	100+	150+	150+	150+	15°F. below
Kinematic Viscosity @ 140°F., CS.	T705	70–140	250–500	800–1600	3000–6000	1.5 Percent*
Distillation	T706	.....	.....	.....	.....	.....
Distillate (percent of total distillate to 680°F.)						
to 437°F.		20—	10—	0	0	1.0
to 500°F.		20–60	15–55	35—	15—	1.0
to 600°F.		65–90	60–87	45–80	15–75	1.0
Residue from distillation to 680°F. Volume Percent of Sample by Difference, Min.		55+	67+	75+	80+	1.0
Tests on Residue from Distillation						
Penetration 77°F.	T717	120–250	120–250	120–250	120–250	8 Percent*
Ductility 77°F., cm. Min.	T720	100+	100+	100+	100+	None
Solubility in CCl_4, Percent Min.	T710	99.5+	99.5+	99.5+	99.5+	.13 Percent below Min.

*When tolerances are expressed in terms of percent, the allowable deviation is calculated as the indicated percentage of the upper or lower specification limit, whichever is applicable.

TABLE IV—Slow Curing Products

Test	Nev. Test Method	Grade; Requirements SC–70	SC–250	SC–800	SC–3000	Allowable Tolerances
Flash Point (C.O.C.) °F	T716	150 Min.	175 Min.	200 Min.	225 Min.	15°F. below
Kinematic Viscosity @ 140°F., CS	T705*	70–140	250–500	800–1600	3000–6000	1.5 Percent**
Distillation						
Total Dist. to 680°F., Vol. Percent.	T706	10–30	4–20	2–12	5 Max.	1.0
Kinematic Viscosity @ 140°F., S	T705*	4–70	8–85	20–140	40–350	1.5 Percent**
Residue of Spec. Pen. (percent duct. of 100 pen.)	T713	50 Min.	60 Min.	70 Min.	80 Min.	.....
Ductility of Asphalt Residue at 77°F., cm	T720	100 Min.	100 Min.	100 Min.	100 Min.	None
Solubility in CCl_4, Percent	T710	99.5 Min.	99.5 Min.	99.5 Min.	99.5 Min.	.13 Percent below Min.
Water in Petroleum Products & Other Bitum. Matls., Percent	T703	0.5 Max.	0.5 Max.	0.5 Max.	0.5 Max.	None

*Test Method No. Nev. T721 (Saybolt Viscosity) may be substituted at the option of the Engineer. When Test Method Nev. No. T721 is used, a conversion factor for correlation shall be used. Said conversion factors shall be those prescribed in "The Asphalt Institute (Pacific Coast Division)" publication of "Specification Tables and Uses," dated February, 1965, and revised January, 1966.

**When tolerances are expressed in terms of percent, the allowable deviation is calculated as the indicated percentage at the upper or lower specification limits, whichever is applicable.

Liquid asphalts not conforming to the requirements of Tables II, III, and IV will be assessed demerits in accordance with the graduated increments of the following schedule. Attention is directed to subsection 109.02, "Scope of Payment," where demerits will be evaluated for damages sustained by reason of any non-compliance.

Test Method	Increment	Demerits (each increment of noncompliance)
Nev. T716	**	5
Nev. T705	RC–MC–SC–70 2 centistokes*	1
	RC–MC–SC–250 10 centistokes*	1
	RC–MC–SC–800 50 centistokes*	1
	RC–MC–SC–3000 100 centistokes*	1
Nev. T706	5 percent below min.	1
Nev. T717 (residue)	0.1 millimeter above max. or below min.	1
Nev. T720 (residue)	5 centimeters below min.	2
Nev. T710	0.05 percent below min.	5

*Above Max. or below Min.
**Material that flashes below the minimum requirements will be assessed five demerits without regard to the number of degrees below minimum.

703.03.04 Emulsified Asphalt. Emulsified asphalt shall conform to the requirements of Tables V and VI for the type and grade specified when tested in accordance with Nev. as is enumerated.

TABLE V—Specifications for Cationic Asphalt Emulsions

Test	Nev. Test Method	Grade; Requirements — Rapid Setting RS–2K	Rapid Setting RS–3K	Medium Setting SM–K	Slow Setting SS–K	Slow Setting SS–Kh	Allowable Tolerances
Tests on Emulsion							
Furol Viscosity at 77°F., sec.	T707	.....	.....	.....	20–100	20–100	None
Furol Viscosity at 122°F., sec.	T707	20–100	100–400	50–500	.....	.....	None
Residue from Distillation, Percent by Weight	T707	60+	65+	60+	57+	57+	1.0
Settlement, 7 Days, Percent Difference	T707	3—	3—	3—	3—	3—	None
Sieve Test (retained on no. 20), Percent	T707*	0.10—	0.10—	0.10—	0.10—	0.10—	None
Aggregate Coating-Water Resistance Test							
Dry Aggregate (job), Percent Coated		.....	.....	80+	.....	.....	None
Wet Aggregate (job), Percent Coated		.....	.....	60+	.....	.....	None
Cement Mixing Test, Percent	T707	.....	.....	.....	2—	2—	None
Particle Charge Test	T708	.....	Positive	Positive	.....	.....	None
pH		.....	.....	.....	6.7—	6.7—	None

Oil Distillate, Percent by Volume	T707	5—	5—	20—	.....	.....	None
Tests on Residue							
Penetration, 77°F., 100 g., 5 sec.	T717	80–250	80–250	100–250	100–200	40–90	15 Percent
Solubility in $CC1_4$, Percent	T710**	97.0+	97.0+	97.0+	97.0+	97.0+	.13 Percent below Min.
Ductility, 77°F., cm.	T720	40+	40+	40+	40+	40+	None

*Except that distilled water is used instead of sodium oleate solution.
**Except that carbon tetrachloride is used instead of carbon disulphide as solvent, Method No. 1 in Test Method Nev. No. T710.
Note: a. "K" in grade designations signifies cationic type
b. In Medium Setting Grade—"SM" indicates sand mixing grade

TABLE VI—Specifications for Anionic Emulsified Asphalts

Test	Nev. Test Method	Grade; Requirements				Allowable Tolerances
		Rapid Setting		Slow Setting		
Tests on Emulsion		RS–1	RS–2	SS–1	SS–1h	
Furol Viscosity at 77°F., Sec.		20–100	.....	20–100	20–100	None
Furol Viscosity at 122°F., Sec.		.....	75–400	.....	.....	None
Residue from Dist., Percent by Weight		57+	62+	57+	57+	1.0
Settlement, 5 Days, Percent Difference	T707	3—	3—	3—	3—	None
Particle Charge Test	T708	Negative	Negative	.....	.....	None
Demulsibility:						
35 ml. of 0.02 N $CaCl_2$, Percent		60+	50+	.....	.....	None
50 ml. of 0.10 N $CaCl_2$, Percent		.....	.....	.....	.....	None
Sieve Test (retained on no. 20), Percent		0.10—	0.10—	0.10—	0.10—	None
Cement Mixing Test, Percent		.....	.....	2.0—	2.0—	None
Tests on Residue						
Penetration, 77°F., 100 g., 5 Sec.	T717	100–200	100–200	100–200	40–90	15 Percent
Solubility in CCl_4, Percent	T710*	97.5+	97.5+	97.5+	97.5+	.13 Percent below Min.
Ductility, 77°F., cms.	T720	40+	40+	40+	40+	None

*Except that carbon tetrachloride is used instead of carbon disulphide as solvent, Method No. 1 in Test Method Nev. No. T710.

Emulsified asphalts not conforming to the requirements of Tables V and VI will be assessed demerits in accordance with the graduated increments of the following schedule. Attention is directed to subsection 109.02, "Scope of Payment," where demerits will be evaluated for damages sustained by reason of any noncompliance.

Test Method	Increment	Demerits (each increment of noncompliance)
Nev. T707 (viscosity) @ 77°F. and @ 122°F.	2 Seconds Above Max. or Below Min.	1
Nev. T707 (residue)	5 Percent Below Min.	1
Nev. T708		21
Nev. T717 (pen. of residue)	0.2 Millimeter Above Max.	1
	1.0 Millimeter Below Min.	1
Nev. T720 (residue)	5 Centimeters Below Min.	2
Nev. T710	0.05 Percent Below Min.	5

SECTION 704

BASE AGGREGATES

SCOPE

704.01.01 Materials Covered. This specification covers the quality and size of mineral materials used in base courses.

REQUIREMENTS

704.02.01 General. The mineral aggregate shall be the product of approved deposits. The Engineer reserves the right to prohibit the use of aggregates from any source when:

(a) The character of the material is such, in the opinion of the Engineer, as to make improbable the furnishing of aggregates conforming to the requirements of these specifications.
(b) The character of the material is such, in the opinion of the Engineer, that undue additional costs may be accrued by the State.

The mineral aggregate shall be clean, hard, durable, free from frozen lumps, deleterious matter, and harmful adherent coatings.

704.02.02 Deficiencies. If the product of a deposit is deficient in material passing the No. 16 sieve, filler from other approved deposits may be added at the crushing and screening plants. This is not to be construed as a waiver of any of the requirements contained herein.

704.02.03 Plastic Limits. When specified, aggregates shall conform to the applicable requirements of the following table:

TABLE I

Percentage by Weight *Passing 200 Sieve	Plasticity Index Maximum
0.1 to 3.0	15
3.1 to 4.0	12
4.1 to 5.0	9
5.1 to 8.0	6
8.1 to 11.0	4
11.1 to 15.0	3

*Test Method No. Nev. T206.

PHYSICAL PROPERTIES AND TESTS

704.03.01 Drain Backfill. This aggregate shall conform to one of the following grading requirements:

	Percentage by Weight Passing Sieve		
Sieve Sizes	Type 1	Type 2	Type 3
2 Inch	100	.....	.....
1½ Inch	90–100	100	.....
¾ Inch	60–90	90–100	.....
⅜ Inch	.....	.....	100
No. 4	40–70	45–75	80–100
No. 16	18–55	20–60	40–80
No. 50	7–25	7–25	8–30
No. 100	0–4	0–4	0–5
No. 200	0–3	0–3	0–3

Unless otherwise specified in the contract documents, the Contractor may use either Type 1, 2, or 3.

704.03.02 Type 1 Class A Aggregate Base. This aggregate shall conform to the following requirements:

Sieve Sizes	Percent By Weight Passing Sieve
2 Inch	100
1½ Inch	90–100
¾ Inch	55–85
No. 4	25–50
No. 16	10–30
No. 200	0–10

Test	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Resistance (R value)	Nev. T115	80 Min.
Percentage of Wear (500 rev)	Nev. T233	37 Percent Max.
Crushed Particles	Nev. T230	90 Percent Min.
Plasticity Index	Nev. T212	Table I
Liquid Limit	Nev. T210	35 Max.

704.03.03 Type 1 Class B Aggregate Base. This aggregate shall conform to the following requirements:

Sieve Sizes	Percent By Weight Passing Sieve
2 Inch	100
1½ Inch	90–100
No. 4	20–55
No. 200	0–12

Test	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Resistance (R value)	Nev. T115	60 Min.
Crushed Particles	Nev. T230	15 Percent Min.
Plasticity Index	Nev. T212	Table I
Liquid Limit	Nev. T210	35 Max.

704.03.04 Type 2 Class A Aggregate Base. This aggregate shall conform to the following requirements:

Sieve Sizes	Percent By Weight Passing Sieve
1 Inch	100
¾ Inch	90–100
No. 4	40–60
No. 16	20–35
No. 200	2–10

Test	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Resistance (R value)	Nev. T115	80 Min.
Percentage of Wear (500 rev)	Nev. T233	37 Percent Max.
Crushed Particles	Nev. T230	90 Percent Min.
Plasticity Index	Nev. T212	Table I
Liquid Limit	Nev. T210	35 Max.

704.03.05 Type 2 Class B Aggregate Base. This aggregate shall conform to the following requirements:

Sieve Sizes	Percent By Weight Passing Sieve
1 Inch	100
¾ Inch	90–100
No. 4	35–65
No. 16	15–40
No. 200	2–10

Test	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Resistance (R value)	Nev. T115	80 Min.
Percentage of Wear (500 rev)	Nev. T233	45 Percent Max.
Crushed Particles	Nev. T230	50 Percent Min.
Plasticity Index	Nev. T212	Table I
Liquid Limit	Nev. T210	35 Max.

704.03.06 Type 3 Class A Aggregate. All requirements will be specified in the special provisions.

704.03.07 Type 3 Class B Aggregate. All requirements will be specified in the special provisions.

704.03.08 Aggregate for Portland Cement Treated Base. This aggregate shall conform to the following requirements:

Sieve Sizes	Percent By Weight Passing Sieve
1 Inch	100
¾ Inch	90–100
No. 4	35–75
No. 16	15–45
No. 200	2–15

Test	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Sand Equivalent	Nev. T227	20 Min.
Percentage of Wear (500 rev)	Nev. T233	45 Percent Max.

SECTION 705

AGGREGATES FOR BITUMINOUS COURSES

SCOPE

705.01.01 Materials Covered. This specification covers the quality and size of local mineral materials and commercial mineral fillers used in bituminous base and surface courses.

REQUIREMENTS

705.02.01 General. The mineral aggregate shall be the product of approved deposits. The Engineer reserves the right to prohibit the use of aggregates from any source when:

(a) The character of the material is such, in the opinion of the Engineer, as to make improbable the furnishing of aggregates conforming to the requirements of these specifications.

(b) The character of the material is such, in the opinion of the Engineer, that undue additional costs may be accrued by the State.

The mineral aggregate shall be clean, hard, durable, free from frozen lumps, deleterious matter, and harmful adherent coatings.

705.02.02 Deficiencies. If the product of any deposit is deficient in the fraction passing the No. 16 sieve, additional filler from other approved deposits meeting the physical requirements may be added. The added material shall be fed to the drier in a uniform manner from a separate stockpile. If the added material is a commercial mineral filler, it shall be uniformly fed directly to the plant. This is not to be construed as a waiver of any of the requirements contained herein.

PHYSICAL PROPERTIES AND TESTS

705.03.01 Plantmix and Roadmix Bituminous Base and Surface Aggregate, Types 1, 2, and 3. The aggregate shall conform to the following requirements:

Sieve Sizes	Percentage by Weight Passing Sieve — Type 1 1½" Max.	Type 2 ¾" Max.	Type 3 ⅜" Max.
2 Inch	100	.....	.....
1½ Inch	90–100	.....	.....
1 Inch	.....	100	.....
¾ Inch	55–85	90–100	.....
½ Inch	.....	.....	100
⅜ Inch	.....	55–85	90–100
No. 4	25–55	35–65	60–80
No. 16	10–35	15–40	25–50
No. 200	3–9	3–9	4–12

Test	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Percentage of Wear (100 rev)	Nev. T233	10 Percent Max.
Percentage of Wear (500 rev)	Nev. T233	45 Percent Max.
Crushed Particles	Nev. T230	50 Percent Min.
Plasticity Index	Nev. T212	6 Percent Max.
Liquid Limit	Nev. T210	30 Max.
Stabilometer Value (type 2)	Nev. T303	35 Min.
Stabilometer Value (type 1 and 3)	Nev. T303	30 Min.
Moisture Vapor Susceptibility (stabilometer value)	Nev. T312	25 Min.
Swell Test	Nev. T304	0.030" Max.
Stripping Test	Nev. T209	Satisfactory

705.03.02 Plantmix Surface Aggregate, Type 4. The combined aggregates shall conform to the following requirements:

Sieve Sizes	Percent By Weight Passing Sieve Type 4—¾" Max.
1 Inch	100
¾ Inch	90–100
⅜ Inch	55–85
No. 4	35–65
No. 16	15–40
No. 200	3–9

Test	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	-------
Percentage of Wear (100 rev)	Nev. T233	10 Percent Max.
Percentage of Wear (500 rev)	Nev. T233	45 Percent Max.
Crushed Particles (coarse agg.)	Nev. T230	90 Percent Min.
Crushed Particles (fine agg.)	Nev. T230	70 Percent Min.*
Plasticity Index	Nev. T212	6 Percent Max.
Liquid Limit	Nev. T210	30 Percent Max.
Stabilometer Value	Nev. T303	37 Min.
Moisture Vapor Susceptibility (stabilometer value)	Nev. T312	30 Min.
Swell Test	Nev. T304	0.030" Max.
Stripping Test	Nev. T209	Satisfactory

*Required only on that portion passing the No. 4 sieve and retained on the No. 8 sieve.

705.03.03 Plantmix Bituminous Open-Graded Surface Aggregate. The aggregate shall conform to the following requirements:

Sieve Sizes	Percent By Weight Passing Sieve
½ Inch	100
⅜ Inch	90–100
No. 4	35–55
No. 16	2–18
No. 200	0–3

Test	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	-------
Percentage of Wear (100 rev)	Nev. T233	10 Percent Max.
Percentage of Wear (500 rev)	Nev. T233	45 Percent Max.
Crushed Particles	Nev. T230	90 Percent Min.
Swell Test	Nev. T304	0.030" Max.
Stripping Test	Nev. T209	Satisfactory

705.03.04 Commercial Mineral Filler. Commercial mineral filler shall conform to the requirements of AASHO M17.

705.03.05 Screenings. The screenings shall conform to the following requirements:

	Percentage By Weight Passing Sieve	
Sieve Sizes	½" Size	⅜" Size
½ Inch	100	-------
⅜ Inch	90–100	100
No. 4	15–50	30–60
No. 16	0–5	0–8
No. 200	0–2	0–2

Test	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Percent of Wear (100 rev)	Nev. T233	10 Percent
Percent of Wear (500 rev)	Nev. T233	40 Percent
Crushed Particles	Nev. T230	90 Percent Min.
Soundness (5 alternations) (sodium sulphate)	Nev. T470	10 Percent Max. Loss

705.03.06 Sand Blotter. The sand shall conform to the following requirements:

Sieve Sizes	Percent By Weight Passing Sieve
½ Inch	100
No. 4	90–100
No. 16	30–75
No. 200	0–12

Test	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Organic Impurities	Nev. T498	.....

SECTION 706

AGGREGATES FOR PORTLAND CEMENT PRODUCTS

SCOPE

706.01.01 Materials Covered. This specification covers the quality and size of aggregates used in Portland cement products.

REQUIREMENTS

706.02.01 General. The mineral aggregate shall be the product of approved deposits. The Engineer reserves the right to prohibit the use of aggregates from any source when:

(a) The character of the material is such, in the opinion of the Engineer, as to make improbable the furnishing of aggregates conforming to the requirements of these specifications.

(b) The character of the material is such, in the opinion of the Engineer, that undue additional costs may be accrued by the State.

PHYSICAL PROPERTIES AND TESTS

706.03.01 Coarse Aggregate. The aggregate shall conform to the following requirements:

Sieve Sizes	Percentage by Weight Passing Sieve						
	Size No. 3 (2″ to 1″)	Size No. 4 (1½″ to ¾″)	Size No. 7 (½″ to No. 4)	Size No. 57 (1″ to No. 4)	Size No. 67 (¾″ to No. 4)	Size No. 357 (2″ to No. 4)	Size No. 467 (1½″ to No. 4)
2½ Inch	100	.....	.....	.....	.....	100	.....
2 Inch	95–100	100	.....	.....	.....	95–100	100
1½ Inch	35–70	90–100	.....	100	.....	.....	95–100
1 Inch	0–15	20–55	.....	95–100	100	35–70	.....
¾ Inch	.....	0–15	100	.....	90–100	.....	35–70
½ Inch	0–5	.....	90–100	25–60	.....	10–30	.....
⅜ Inch	.....	0–5	40–70	.....	20–55	.....	10–30
No. 4	.....	.....	0–15*	0–10*	0–10*	0–5	0–5

*Not more than five (5) percent shall pass No. 8 sieve.

NOTE: Sizes No. 357 and No. 467 shall each be split into two sizes. Size No. 357 shall be furnished in stockpile or bunker in sizes No. 3 (2″ to 1″) and size No. 57 (1″ to No. 4). Size No. 467 shall be furnished in stockpile or bunker in Size No. 4 (1½″ to ¾″) and Size No. 67 (¾″ to No. 4). The two sizes shall be uniformly combined at the mixing plant to comply with the grading requirements of Sizes No. 357 and No. 467 respectively.

Test	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Material Passing 200 Sieve	Nev. T499	1 Percent Max.
Percentage of Wear (100 rev)	Nev. T233	10 Percent Max.
Percentage of Wear (500 rev)	Nev. T233	50 Percent Max.
Soundness (5 alternations)	Nev. T470	12 Percent Max. Loss
Clay Lumps	Nev. T490	0.3 Percent Max.

Thin or elongated pieces (length greater than five times maximum thickness) shall not exceed fifteen (15) percent by weight.

706.03.02 Lightweight Aggregates. These aggregates shall conform to the following requirements:

Sieve Size	Percentage by Weight Passing Sieve			
	Fine Natural	Fine Lightweight	1" Size Coarse	¾" Size Coarse
1 Inch	-----	-----	95–100	100
¾ Inch	-----	-----	-----	90–100
½ Inch	-----	-----	25–60	-----
⅜ Inch	100	100	-----	20–60
No. 4	95–100	85–100	0–10	0–10
No. 16	45–80	40–80	-----	-----
No. 50	10–35	10–35	-----	-----
No. 100	2–12	5–25	-----	-----
No. 200	0–5	-----	-----	-----

Test	Test Method	Requirements
Sieve Analysis	Nev. T206	Above (a)
Sampling	Nev. T200	-----
Unit Weight (loose oven dry)	Nev. T119	Fine Agg.—70 lb. cu.ft. Max. (b) Coarse Agg.—55 lb. cu.ft. Max. (b) Comb. Fine and Coarse—65 lb. cu. ft. Max. (b)
Organic Impurities	Nev. T498	Satisfactory (c)
Clay Lumps	Nev. T490	2.0 Percent Max.
Test for Staining Materials	Nev. T488	Satisfactory (d)
Mortar Making Properties of Sand	Nev. T472	90 Percent Min. (e)

(a) With the following exceptions: The weight of the test sample for fine lightweight aggregate shall be in accordance with Table III, and the aggregate when mechanically sieved shall be sieved for only 5 minutes. The test

sample for coarse aggregate shall consist of no less than 0.1 cu. ft. of the material used for the determination of unit weight.

Table III

Weight of Sieve Test Sample for Fine Lightweight Aggregates

Nominal Weight of Aggregate Lbs. Per Cubic Foot	Weight of Test Sample, Grams
25–35	150
35–45	200
45–55	250
55–65	300
65–70	350

(b) The unit weight of successive shipments of lightweight aggregate shall not differ by more than ten (10) percent from that of the sample submitted for acceptance tests.

(c) Aggregates tested and showing color darker than the standard shall be rejected unless it can be demonstrated that the discoloration is due to small quantities of materials not harmful to the concrete.

(d) Aggregates tested and showing stain darker than "heavy stain" (stain index of 80) or darker shall be tested by chemical procedure, and aggregates that contain 1.5 mg. or more of ferric oxide (Fe_2O_3) per 200 gram sample shall be rejected for use.

(e) Fine aggregates, subjected to the test for mortar making properties, shall develop a compressive strength at the age of seven (7) and twenty-eight (28) days when using Type 1 or 2 cement of not less than ninety (90) percent of the strength developed by a mortar prepared in the same manner with the same cement and graded Ottawa sand having a fineness modulus of 2.40 ± 0.10.

706.03.03 Fine Aggregate. This aggregate shall conform to the following requirements:

Sieve Sizes	Percent By Weight Passing Sieve
⅜ Inch	100
No. 4	95–100
No. 16	45–80
No. 50	10–35
No. 100	2–12
No. 200	0–5

Test	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Soundness (5 alternations) (sodium sulphate)	Nev. T470	10 Percent Max. Loss
Clay Lumps	Nev. T490	1.0 Percent Max.
Lightweight Pieces in Agg	Nev. T487	1.0 Percent Max.
Percentage of Particles of Less than 1.95 Sp. Gr.	Nev. T486	3.0 Percent Max.
Organic Impurities	Nev. T498	Satisfactory (a)
Mortar Making Properties	Nev. T472	90 Percent Min. (b)

(a) Aggregates tested and showing color darker than the standard shall be rejected unless they pass the "Mortar Making Properties" test (Nev. T472).

(b) Fine aggregates, subjected to the test for mortar making properties, shall develop a compressive strength at the age of seven (7) and twenty-eight (28) days when using Type 1 or 2 cement of not less than ninety (90) percent of the strength developed by a mortar prepared in the same manner with the same cement and graded Ottawa sand having a fineness modulus of 2.40 $\pm$ 0.10.

706.03.04 Grout and Mortar Sand. This aggregate shall conform to the following requirements:

Sand for grout and mortar shall conform to the size requirements of 706.03.03, "Fine Aggregate," except if the Contractor elects, he may screen the sand over a No. 8 screen to produce the following:

Sieve Sizes	Percent By Weight Passing Sieve
No. 8	100
No. 50	15–40
No. 100	0–10
No. 200	0–5

Test	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Mortar Making Properties	Nev. T472	90 Percent Min. (a)
Organic Impurities	Nev. T498	Satisfactory (b)

(a) Fine aggregates, subjected to the test for mortar making properties, shall develop a compressive strength at the age of seven (7) and twenty-eight (28) days when

using Type 1 or 2 cement of not less than ninety (90) percent of the strength developed by a mortar prepared in the same manner with the same cement and graded Ottawa sand having a fineness modulus of 2.40 ± 0.10.

(b) Aggregates tested and showing color darker than the standard shall be rejected.

706.03.05 Stone for Masonry and Riprap. This stone shall conform to the following requirements:

Test	Test Method	Requirements
Percentage of Wear (500 rev)	Nev. T233	50 Percent Max.

SECTION 707

JOINT MATERIAL

SCOPE

707.01.01 Material Covered. This specification covers the quality requirements for poured filler, preformed fillers, and resilient and rubber type gaskets used in the construction of bridges, culverts, sidewalks, etc.

PHYSICAL PROPERTIES AND TESTS

707.03.01 Joint Fillers. Preformed fillers for joints shall conform to the requirements of AASHO M153, ASTM D1751 or D1752 as specified, and shall be punched to admit the dowels where called for on the plans. Unless otherwise specified, AASHO M153, Type III shall apply. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint unless otherwise authorized by the Engineer. When the use of more than one piece is authorized for a joint, the abutting ends shall be fastened securely and held accurately in place, by stapling or other positive fastening satisfactory to the Engineer.

707.03.02 Rubber Gaskets. The ring gaskets shall conform to the requirements of AASHO M198.

707.03.03 Waterstops. Waterstops shall conform to the following requirements:

(a) Natural Rubber—

Test	Test Method	Requirements
Tension Testing of Vulcanized Rubber	ASTM D412	Tensile strength 3,500 lbs. Min. PSI—Elongation at breaking of 550 percent. Unit stress (300 percent) 1,100 lbs. PSI Min. Unit stress (500 percent) 2,800 lbs. PSI Min.

Test	Test Method	Requirements
Test for Accelerated aging of Vulcanized Rubber by the Oxygen Pressure Method	ASTM D572	After 7 days in air at 158° (±2°)F. or after 48 hours in oxygen at 158° (±2°)F. and 300 lbs. PSI, the tensile strength and elongation shall not be less than 65 percent of the original.
Test for Indentation of Rubber by Means of a Durometer	ASTM 676	55 to 65 (hardness)

Natural rubber waterstops shall be manufactured from a stock composed of a high grade compound made exclusively from new plantation rubber reinforced carbon black, zinc oxide, accelerators, antioxidants, and softeners. This compound shall contain not less than seventy-two (72) percent by volume of new plantation rubber.

(b) Synthetic Rubber—

Test	Test Method	Requirements
Tension Testing of Vulcanized Rubber	ASTM D412	Tensile strength 2,500 lbs. PSI Min. Elongation at breaking of 425 percent.
Testing for Accelerated Aging of Vulcanized Rubber by the Oxygen Pressure Method	ASTM D572	After 7 days in air at 158° (±2°)F. or after 48 hours in oxygen at 158° (±2°)F. and 300 lbs. PSI, the tensile strength and elongation shall not be less than 65 percent of the original.
Test for Indentation of Rubber by Means of a Durometer	ASTM 676	50 to 70 (hardness)

(c) Polyvinyl Chloride—

Test	Test Method	Requirements
Polyvinyl Chloride Waterstops	Corps. of Engr. CRD–C572	Compliance of paragraph 6

SECTION 708

CONCRETE AND CLAY PIPE AND DRAINS

SCOPE

708.01.01 Materials Covered. This specification covers the quality of clay pipe, nonreinforced concrete pipe, and reinforced concrete pipe used for culverts, siphons, pressure conduits, sewers, and storm drains. Also the quality of perforated pipe used in underdrains.

PHYSICAL PROPERTIES AND TESTS

708.03.01 Reinforced Concrete Pipe. This pipe shall conform to the requirements of AASHO M170 for the specified diameters and strength classes. Elliptical pipe shall be furnished where specified. Unless otherwise specified, pipe wall design and use of elliptical reinforcement in circular pipe are optional.

Precast reinforced concrete end sections shall conform to the requirements of the cited specifications to the extent to which they apply.

708.03.02 Nonreinforced Concrete Pipe. This pipe shall conform to the requirements of AASHO M86 for the specified diameters and strength classes.

708.03.03 Perforated Concrete Pipe. This pipe shall conform to the requirements of AASHO M175 or to ASTM C444 for the specified diameters and strength classes.

708.03.04 Clay Pipe. This pipe shall conform to the requirements of AASHO M65 for pipe with full circular cross section, for the specified diameter and strength class. When specified, the bell shall have integral spacer lugs to provide for an annular opening and self-centering feature.

708.03.05 Bituminous Fiber Pipe. This pipe shall conform to the requirements of AASHO M158, ASTM D1861 or D1862.

708.03.06 Perforated Bituminous Fiber Pipe. This pipe shall conform to the requirements of AASHO M177 for the specified diameters. Unless otherwise specified, either Type 1 or Type 2 couplings may be furnished.

SECTION 709

METAL PIPE AND DRAINS

SCOPE

709.01.01 Material Covered. This specification covers the quality of metal pipes, metal arch pipes, metal end sections, structural plate pipe, and perforated metal pipe used for culverts, drainage structures, conduits, and underdrains.

PHYSICAL PROPERTIES AND TESTS

709.03.01 Corrugated Metal Pipe and Pipe Arches. These conduits and the coupling bands shall conform to the requirements of AASHO M36 for the specified sectional dimensions and spelter coating and gages. Shop-formed elliptical pipe and shop strutted pipe shall be furnished where specified.

Special sections, such as elbows and flared end sections, for these conduits shall be of the same gage as the conduit to which they are joined, and shall conform to the applicable requirements of AASHO M36.

709.03.02 Bituminous Coated Corrugated Metal Pipe and Pipe Arches. These conduits and the coupling bands shall conform to the requirements of AASHO M190 for the specified sectional dimensions, gages, and type of bituminous coating. Coupling bands shall be fully coated with bituminous material. Shop-formed elliptical pipe and shop strutted pipe shall be furnished where specified.

Special sections, such as elbows and flared end sections, for these conduits shall be of the same gage as the conduit to which they are joined, and shall conform to the applicable requirements of AASHO M190. Coating and invert paving shall be of the type specified.

When asbestos bonded bituminous coating is specified, these requirements shall equally apply and in addition the special process of embedding asbestos fiber in the molten metallic bonding medium shall be used to bond the bituminous coating.

709.03.03 Corrugated Aluminum Pipe. This pipe shall conform to the requirements of AASHO M196.

709.03.04 Corrugated Metal Pipes for Downdrains. Downdrain flumes and pipe shall conform to the requirements of AASHO M36. Type III inlets shall conform to the requirements of AASHO M36. Type I and Type II inlets shall conform to the requirements of ASTM A93 except 2.00 ounce coating shall be required. When specified, pipe, flumes, and inlets shall be bituminous coated conforming to the requirements of AASHO M190. All anchor assemblies, hardware, and accessories shall conform to the requirements of ASTM A153 and ASTM A123.

709.03.05 Corrugated Metal Pipe for Underdrains. This pipe shall conform to the requirements of AASHO M136 for the specified diameters. Unless otherwise specified, any one of four types may be furnished.

709.03.06 Bituminous Coated Corrugated Metal Pipe for Underdrains. This pipe shall conform to the requirements of AASHO M136 and shall be coated with bituminous material to meet requirements of AASHO M190, Type A coating, except that minimum coating thickness shall be 0.03 inch. Coupling bands shall be full coated. The specified minimum diameter of perforations shall apply after coating.

709.03.07 Corrugated Aluminum Pipe for Underdrains. This pipe shall conform to the requirements of AASHO M197.

709.03.08 Structural Plate Pipe and Pipe Arches. This pipe shall conform to the requirements of AASHO M167.

SECTION 710

STRUCTURAL AND EYEBAR STEEL

SCOPE

710.01.01 Material Covered. This specification covers the quality of structural and eyebar steel used in highway structures.

REQUIREMENTS

710.02.01 Defects. Finished rolled material shall be free from cracks, flaws, injurious seams, laps, blisters, ragged and imperfect edges, and other defects. It shall have a smooth, uniform finish, and shall be straightened in the mill before shipment.

Material shall be free from loose mill scale, rust pits, or other defects affecting its strength or durability.

The Engineer reserves the right to reject material which he deems unsuitable for the purpose intended even though the material meets the requirements of the mill tolerances.

PHYSICAL PROPERTIES AND TESTS

710.03.01 Standard Steel. This steel shall conform to the requirements of ASTM A36.

710.03.02 High Strength-Low Alloy Structural Manganese Vanadium Steel. This steel shall conform to the requirements of ASTM A441.

710.03.03 High Tensile Strength Bolts. This steel shall conform to the requirements of ASTM A325.

710.03.04 Stainless Steel Bolts. This steel shall conform to the requirements of ASTM A276.

710.03.05 Welded Seamless Steel Pipe. This steel shall conform to the requirements of ASTM A53 (Grade B).

710.03.06 Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes. This steel

shall conform to the requirements of ASTM A500 (Grade B) except the minimum tensile strength shall be 55,000 psi.

710.03.07 Shear Connector Studs. This steel shall conform to the requirements of ASTM A108, Grade 1015, or 1020. Flux-retaining caps shall be low carbon grade suitable for welding and shall conform to the requirements of ASTM A109.

710.03.08 Pins and Rollers. Pins or rollers nine (9) inches or less in diameter shall be forged and heat treated or cold finished carbon-steel shafting. Pins or rollers more than nine (9) inches in diameter shall be forged and heat treated in accordance with the requirements of ASTM A235.

SECTION 711

ALUMINUM FOR BRIDGE RAIL

SCOPE

711.01.01 Material Covered. This specification covers the quality of aluminum alloy used in bridge rail.

PHYSICAL PROPERTIES AND TESTS

711.03.01 Aluminum Alloy for Pipe. This pipe shall conform to the requirements of ASTM B241 Alloy 6061–T6 or 6063–T6.

711.03.02 Aluminum Alloy Tubing. This tubing shall conform to the requirements of ASTM B221 Alloy 6061–T6 or 6063–T6.

711.03.03 Cast Aluminum Alloy. This alloy shall conform to the requirements of AASHO M193, Alloy A 344–T4.

711.03.04 Aluminum Alloy Shims. This alloy shall conform to the requirements of ASTM B209 Alloy 1100–0.

SECTION 712

MISCELLANEOUS METAL

SCOPE

712.01.01 Material Covered. This specification covers the type and quality of miscellaneous metals used in various highway constructions.

PHYSICAL PROPERTIES AND TESTS

712.03.01 Steel Castings. This steel shall conform to the requirements of ASTM A27, Grade 65–35.

712.03.02 Gray Iron Castings. These castings shall conform to the requirements of ASTM A48, Class 40.

712.03.03 Malleable Castings. These castings shall conform to the requirements of ASTM A47, Grade 32510.

712.03.04 Wrought Iron Plates. These plates shall conform to the requirements of ASTM A42.

712.03.05 Bronze Castings. These castings shall conform to the requirements of ASTM B22, Alloy E.

712.03.06 Welding Materials. Materials used for welding shall conform to the current Specifications for Welded Highway and Railway Bridges of the American Welding Society.

712.03.07 Steel Piles. This steel ("H" Piles, Sheet Piling), shall conform to the requirements of ASTM A36.

712.03.08 Steel Shell for Piles. This steel shall conform to the requirements of ASTM A252, Grade 2.

SECTION 713

REINFORCEMENT

SCOPE

713.01.01 Materials Covered. This specification covers the quality of bar steel, fabricated reinforcement and welded steel wire used in the reinforcement of concrete.

PHYSICAL PROPERTIES AND TESTS

713.03.01 Bar Steel Reinforcement. This steel shall conform to the applicable following requirements:

Test	Test Method	Requirements
Billet Steel Bars for Concrete Reinforcement	ASTM A15 or ASTM A408	Intermediate or Hard Grade (a)
Rail Steel Bars for Concrete Reinforcement	ASTM A16	Satisfactory
Spiral Reinforcement	ASTM A15	Intermediate Grade Bars

(a) Size Nos. 14 and 18 bars shall conform to all the requirements of the corresponding size Nos. 14S and 18S bars of the current ASTM Designation A408.

713.03.02 Fabricated Steel Bar or Rod Mats Reinforcement. This steel shall conform to the requirements of ASTM A184.

713.03.03 Welded Steel Wire Fabric Reinforcement. This steel shall conform to the requirements of ASTM A185.

713.03.04 Prestressing Steel. Prestressing reinforcement shall be high-tensile-strength steel wire, high-tensile-strength seven-wire strand or high-tensile-strength alloy bars as called for on the plans or in the special provisions.

High-tensile-strength steel wire shall conform to the requirements of ASTM designation A421, except that the steel may be made by the basic oxygen process.

High-tensile-strength seven-wire strand shall conform

to the requirements of ASTM Designation A416 with the exceptions shown in the following table:

Nominal Diameter of Strand (inches)	Breaking Strength Minimum (pounds)	Nominal Area of Strand (sq. in.)	Nominal Weight of Strand (lb. per 1000 ft.)	Yield Strength Requirements — Initial Load (pounds)	Yield Strength Requirements — Minimum Load at 1 Percent Exten. (pounds)
3/8	23,000	0.085	292	2,300	19,600
7/16	31,000	0.117	400	3,100	26,350
1/2	41,300	0.153	525	4,130	35,100

High-tensile-strength alloy bars shall be stress relieved and then cold stretched to a minimum of 130,000 psi. After cold stretching, the physical properties shall be as follows:

Minimum Ultimate Tensile Strength.....145,000 psi
Minimum Yield Strength, Measured by the 0.7 Percent Extension Under Load Method Shall Be Not Less Than.....130,000 psi
Minimum Modulus of Elasticity.....25,000,000 psi
Minimum Elongation in 20-bar Diameters After Rupture.....4 percent
Diameter Tolerance.....+0.03", —0.01"

Testing Prestressing Reinforcement and Anchorages. All wire, strand, or bars to be shipped to the site shall be assigned a lot number and tagged for identification purposes. Anchorage assemblies to be shipped shall be likewise identified.

All samples submitted shall be representative of the lot to be furnished, and, in the case of wire or strand, shall be taken from the same master roll.

All of the materials specified for testing shall be furnished free of cost and shall be delivered in time for tests to be made well in advance of anticipated time of use.

The vendor shall furnish for testing the following samples selected from each lot. If ordered by the Engineer, the selection of samples shall be made at the manufacturer's plant by the inspector.

(a) Pretensioning Method. For pretensioned strands, samples at least five (5) feet long shall be furnished of each strand size. A sample shall be taken from each end of every coil.

(b) Post-Tensioning Method. The following lengths shall be furnished:

1. For wires requiring heading—five (5) feet.
2. For wires not requiring heading—sufficient length to make up one parallel-lay cable five (5) feet long consisting of the same number of wires as the cable to be furnished.
3. For strand to be furnished with fittings—five (5) feet between near ends of fittings.
4. For bars to be furnished with threaded ends and nuts—five (5) feet between threads at ends.

(c) Anchorage Assemblies. Two anchorage assemblies shall be furnished, complete with distribution plates of each size or type to be used, if anchorage assemblies are not attached to reinforcement samples.

SECTION 714

PAINT

SCOPE

714.01.01 Materials Covered. This specification covers the quality, color, and number of applications of paint used in painting the various materials of highway construction. Attention is directed to Section 715, "Galvanizing," for galvanized coatings.

REQUIREMENTS

714.02.01 Certificates. The Contractor shall furnish the Engineer with written certification that all required tests have been satisfactorily completed and that the materials thereof comply with all the requirements. Samples will be taken when required by the Engineer.

PHYSICAL PROPERTIES AND TESTS

714.03.01 Iron and Steel Use Items.

(a) Standard Metal Rail, Steel Bridge Railing and Guardrail when paint is specified.

Purpose	Number of Coats	Color	General Type	Formula or Specification
Prime (applied at shop)	1	-------	Red Lead or Zinc Chromate	*TT–P–86 Type III **JAN–P–735
Intermediate (first field coat after primer)	1	Cream	Titanium Lead, Zinc Oxide	*TT–P–102 Class B
Finish (second field coat after primer)	1	White	Titanium Lead, Zinc Oxide	*TT–P–102 Class B

*Federal Specifications
**National Military Establishment Specification

(b) Structural Steel, Miscellaneous Iron, Steel Light Standards.

Purpose	Number of Coats	Color	General Type	Formula or Specification
Prime (applied at shop)	1	.....	Red Lead or Zinc Chromate	*TT–P–86 Type III **JAN–P–735
Intermediate (first field coat after primer)	1	Lt. Gray	Titanium Lead, Zinc Oxide	*TT–P–102 Class B
Finish (second field coat after primer)	1	.....	Aluminum	*TT–V–81 Mixing Varnish Aluminum Paste *TT–A–468, Type II

*Federal Specifications
**National Military Establishment Specification

714.03.02 Timber Use Items. Cattle guard wings, bridge railings, right-of-way markers, sign posts, and miscellaneous timber structures specified to receive paint.

Purpose	Number of Coats	Color	General Type	Formula or Specification
Prime	1	White	Mixed Pigment Exterior	*TT–P–25
			Wood Primer	*TT–P–25
Intermediate (first coat after primer)	1	Cream	Titanium Lead, Zinc Oxide	*TT–P–102 Class B
Finish (second coat after primer)	1	White	Titanium Lead, Zinc Oxide	*TT–P–102 Class B

*Federal Specifications

Purpose	Number of Coats	Color	General Type	Formula or Specification
Trim, Lettering and Indications (used when so indicated on plans)	1	Black	Titanium Lead, Zinc Oxide	*TT–P–61

*Federal Specifications

714.03.03 Concrete Use Items. Concrete end posts, (bridges), raised traffic bars, and miscellaneous concrete specified to receive paint.

Purpose	Number of Coats	Color	General Type	Formula or Specification
Finish	1	White	Water Thinned	Acrylic Resin or Synthetic Latex Alkyd Emulsion

SECTION 715

GALVANIZING

SCOPE

715.01.01 Material Covered. This specification covers the quality and thickness of galvanize used on various material when called for on the plans or designated in the specifications.

PHYSICAL PROPERTIES AND TESTS

715.03.01 Products One-eighth (⅛) Inch Thick and Thicker. Galvanizing of products fabricated from rolled, pressed, and forged steel shapes, plates, bars, and strip shall conform to the requirements of ASTM Designation A123.

715.03.02 Rail Elements. All rail elements shall be galvanized in accordance with ASTM Designation A525, Coating Class 2.5.

715.03.03 Hardware. Bolts, nuts, washers, and fastenings shall be galvanized in accordance with the requirements of ASTM Designation A153.

SECTION 716

SIGN MATERIALS

SCOPE

716.01.01 Materials Covered. This specification covers the kind and quality of materials used in the construction of "Temporary Signs" and "Permanent Signs."

REQUIREMENTS

716.02.01 General. Traffic signs and markers shall conform to the requirements of the latest edition of AASHO Manuals, "Signing and Pavement Marking of the National System of Interstate and Defense Highways" and "Uniform Traffic Control Devices for Street and Highways."

716.02.02 Certificates. It shall be the Contractor's responsibility to ascertain that all required tests have been made by qualified testing laboratories as approved by the Department. The Contractor shall furnish the Engineer with a written certification that all required tests have been satisfactorily completed and that materials and fabrication thereof comply with all the requirements.

All materials shall be approved prior to use.

PHYSICAL PROPERTIES AND TESTS

716.03.01 General. Bearing plates, wide flange beam posts, and gusset or stiffener plates shall be of the sizes and dimensions shown on the plans and shall be galvanized after fabrication. Steel shall conform to ASTM Designation A36. Galvanizing shall conform to ASTM Designation A123. All welding shall conform to the requirements set forth in subsection 506.03.20, "Welding."

Post clamps for attachment to wide flange beam posts shall be extruded of 6061–T 6 aluminum alloy conforming to ASTM Designation B221, and shall be of the shape and sizes as shown on the plans.

Pipe brackets for attaching sign to pipe posts shall

be of the interlocking type and shall be of aluminum alloy 6061–T 6 and conform to ASTM Designation B221.

Anchor bolts, nuts, and washers shall be of structural, carbon steel conforming to Section 710, "Structural and Eyebar Steel," and shall be galvanized in accordance with ASTM Designation A153 or cadmium plated in accordance with ASTM Designation A165 Type NS.

Steel pipe for posts shall conform to the specifications of ASTM Designation A120 and shall be galvanized.

Aluminum alloy pipe for posts and tubular stiffeners shall be schedule 40 pipe fabricated of 6061–T 6 aluminum alloy and shall conform to the specifications of ASTM Designation B241. Pipe caps for aluminum posts shall be aluminum alloy 356–T 6.

The straps, bars, and braces used on sign support-Type C, shall be of aluminum alloy 6061–T 6 and shall conform to ASTM Designation B209.

Stringers for horizontal supporting structural members and angle for post clamps assembly shall be of 6061–T 6 aluminum alloy and shall conform to ASTM Designation B308.

Sheet aluminum for sign panels and backing for letters other than laminated signs shall be of 6061–T 6 aluminum alloy and shall conform to specifications for ASTM Designation B209. The face sheet of the laminated signs shall be of 6061–H12 aluminum alloy. The back sheet shall be fabricated in one piece from 0.040 inch sheet aluminum alloy 3003–H14. The surface shall be treated with an amorphous chromate conversion coating conforming to the requirements of Federal Specification MIL–C–5541. Core material shall be phenolic impregnated cellulose honeycomb equal to AMS–3720 standards.

Aluminum alloy bolts shall be 2024–T 4 aluminum alloy and shall conform to the specifications of ASTM Designation B211. Stainless steel bolts shall conform to the specifications of ASTM Designation A276.

The expansion assembly for fastening the aluminum tubing to the aluminum Z-bars shall be manufactured of a zinc die casting alloy which contains copper, aluminum,

and magnesium. The anchor bolt for the expansion assembly shall be cadmium plated and shall conform to the specifications of ASTM Designation A165, minimum thickness as prescribed for grade Type TS.

Core material shall be phenolic impregnated cellulose honeycomb equal to AMS–3720 standards. Thickness of core material shall be held within a tolerance of plus 0.010 inch and minus 0.010 inch. Core material shall meet specification MIL–D–5272 for resistance to fungus.

The tensile strength of the 6061 aluminum sheets and honeycomb type laminate construction shall be 35–38 pounds per square inch. The tensile test shall be performed on a Dillon Dynamometer at room temperature with a two by two inch (2″ x 2″) section as a test specimen. The bond obtained after a forty-eight (48) hour aging period shall withstand six complete cycles of the ASTM D–1037 Weathering Test.

SECTION 717

TIMBER PILES

SCOPE

717.01.01 Materials Covered. This specification covers the quality of round timber piles.

REQUIREMENTS

717.02.01 Certificates. Inspection certificates shall be furnished without extra charge with each shipment of timber piles. These certificates shall be issued by the inspection agency under whose rules the material was manufactured and graded.

Timber piles to be treated shall be inspected prior to treatment by an inspector designated by the Engineer. The inspector shall stamp each pile on the butt end with a stamp which shall make an impression that is readily legible after treatment. The stamp shall be copyrighted and a true impression filed with the Department of Highways.

PHYSICAL PROPERTIES AND TESTS

717.03.01 General. Timber piles shall conform to the requirement of ASTM Designation D25 for Class B piles.

SECTION 718

TIMBER

SCOPE

718.01.01 Materials Covered. This specification covers the quality requirements for structural timber, lumber, guardrail posts, markers, and miscellaneous items.

REQUIREMENTS

718.02.01 Grades. Grades furnished shall be as noted on the plans or in the special provisions.

718.02.02 Certificates of Inspection. Inspection certificates shall be furnished without extra charge with each shipment of timber. These certificates shall be issued by the inspection agency under whose rules the material was manufactured and graded.

PHYSICAL PROPERTIES AND TESTS

718.03.01 Species. The standard commercial and botanical names recognized by these specifications are described as follows:

Standard Commercial Name	Botanical Name
Cedar, Port Orford	Chamaecyparis lawsoniana
Fir, Douglas (coast)	Pseudotsuga taxifolia (coast type)
Fir, Douglas (inland)	Pseudotsuga taxifolia (inter-mountain type)
Hemlock, West Coast	Tsuga Heterophylla
Larch	Larix Occidantalis
Redwood, California	Sequoia sempervirens

718.03.02 Grades. Structural timber and lumber shall meet the requirements for the numerical stress shown on the plans, or as may be otherwise specified, when graded by rules developed in accordance with AASHO M168. Any commercial grading rules that will provide material of an equal or greater stress value may be used.

SECTION 719

TIMBER PRESERVATIVES

SCOPE

719.01.01 Materials Covered. This specification covers the type and quality of materials used in the preservative treatment of timber.

PHYSICAL PROPERTIES AND TESTS

719.03.01 Preservatives. Timber preservatives shall conform to the requirements of AASHO M133.

SECTION 720

GUARDRAIL MATERIALS

SCOPE

720.01.01 Materials Covered. This specification covers the quality and kind of material used in the construction of guardrail.

REQUIREMENTS

720.02.01 Certificates. Two certified copies of mill test reports showing the chemical and physical characteristics from each heat from which metal is used shall be furnished by the Contractor.

Certificates for wood posts shall be furnished in accordance with subsection 718.02.02, "Certificates of Inspection."

Rail members, bolts, nuts, and other fittings shall be interchangeable with similar parts regardless of source.

PHYSICAL PROPERTIES AND TESTS

720.03.01 Rail Members. The beam-type members, comprising rail members and end or terminal pieces, shall be formed from (1) open-hearth, basic oxygen, or electric-furnace steel sheets, galvanized either before or after fabrication, or (2) aluminum alloy sheets as the Contractor may elect. The thickness of steel sheets before galvanizing, and the thickness of aluminum sheets shall be not less than 0.100 inch (nominal 12 gage and allowing for tolerances). The metal in the members shall meet the minimum requirements of the following table.

Strength Requirements for Beam-Type Rail Members

	Rail	End Piece
Ultimate Tensile Strength	67,000 psi	.....
Yield Point Strength	.....	25,000 psi
Elongation in Two-Inch Gage Length	12 percent	.....
Total Ultimate Strength at Splices	80,000 lbs.	80,000 lbs.

Steel members shall be galvanized in accordance with Section 715, "Galvanizing."

720.03.02 Fittings. All bolts, nuts, washers, and other fittings for beam-type guardrail shall be steel and of a quality adequate to develop the specified strength of rail splices and to provide a post connection withstanding a five thousand (5,000) pound side pull in either direction.

All bolts, nuts, and washers shall be five-eighths (⅝) inch size. Bolts shall be buttonhead style and nuts shall be hexagonal. Bolts and nuts shall be coarse-threaded (11 per inch), with nuts tapped oversize not to exceed one thirty-second ($\frac{1}{32}$) inch. Outside dimensions of boltheads, nuts and washers shall have the following minimums: boltheads one and one-fourth (1¼) inches; nuts, fifteen-sixteenths ($\frac{15}{16}$) inch; and washers, one and one-half (1½) inches. Splice bolts shall be one and one-fourth (1¼) inches in length, and post connection bolts shall be of lengths required to fit the post dimension and extend beyond the tightened nuts thereon within limits of one-fourth (¼) to one-half (½) inch. Washers, one-eighth (⅛) inch thick, shall be provided for use under nuts on all post bolts, and under any nut which has a width of less than one and one-sixteenths ($1\frac{1}{16}$) inches.

All fittings shall be galvanized in accordance with Section 715, "Galvanizing."

720.03.03 Reflector Plates. Reflector plates shall be fabricated from sixteen (16) gage steel sheet or eighty thousandths (0.080) inch thick aluminum sheet alloy 6061–T6. Nails for fastening reflector plates to the guardrail post shall be either galvanized metal or aluminum. Steel reflector plates shall be galvanized. Reflectorized material for reflector plates shall conform to the requirements of subsection 721.03.03, "Reflectors."

SECTION 721

CULVERT MARKERS AND GUIDE POSTS

SCOPE

721.01.01 Materials Covered. This specification covers the quality and kind of materials used in the construction of culvert markers and guide posts.

REQUIREMENTS

721.02.01 Certificates. Without expense to the Department, two certificates covering each order of material (plates, reflectors, and posts) shall be furnished by the manufacturer, certifying that the product complies with the specifications. Certificates shall be delivered to the Engineer in charge at the job site at the time of, or prior to, delivery of the order.

For steel used in posts, the Contractor shall furnish two certified copies of mill test reports showing the chemical and physical characteristics from each heat.

PHYSICAL PROPERTIES AND TESTS

721.03.01 Metal Posts. Posts shall be steel conforming to ASTM Designation A245 Grade C with the following modifications:

Tensile Strength	67,000 psi
Yield Point	33,000 psi
Elongation in 8 Inches	18 percent
Bending Properties	Specimen shall withstand a cold bend, at room temperature, of 180° around a mandrel of a diameter equal to one and one-half times the thickness of the material without cracking on the outside of the bent portion.

Metal posts shall be galvanized in accordance with Section 715, "Galvanizing."

721.03.02 Target Plates. (a) Base Metal. Base metal for target plates shall be zinc-coated steel sheet or aluminum sheet.

The zinc-coated steel sheet shall comply with Federal Specification QQ–S–775 Steel Sheet, carbon, zinc-coated Type 1, Classes d and e, except that the zinc-coated surface shall withstand a one hundred eighty (180) degree bend on itself at room temperature without flaking the coating. The zinc-coated surface shall be prepared for painting by the application of phosphate coating. Surface preparation shall conform to the following requirements: The phosphatizing process shall be accomplished without damaging or removing the galvanized coating from the steel base metal. Any evidence of damage or removal of the zinc coating shall be cause for rejection of the entire lot.

The aluminum sheet shall be prepared for painting with a chemical conversion coating conforming to the requirements of Federal Specification MIL–C–5541. The coating shall be applied in accordance with the manufacturer's specifications and recommended sequence of operation. Two copies of certified mill tests of the aluminum sheets shall be furnished to the Engineer.

Target plates shall be fabricated from twenty (20) gage steel sheet or fifty thousandths (0.050) inch thick aluminum sheet, alloy 3105–H25.

Fabrication of all metal parts shall be accomplished in a uniform and workmanlike manner. Plates shall be cut to size and shape and the holes punched for mounting bolts and reflectors in accordance with the details shown on the plans. Surfaces and edges of the plates shall be free from defects resulting from fabrication.

(b) Paint. Target plates shall have satisfactory paint adherence.

The plates shall be coated with baked enamel conforming to the following provisions:

The enamel finish coat for plates shall comply in all respects with the requirements of Federal Specification TT–E–489, Class B baking type enamel, with the added requirement that the yellowness index of the white enamel shall not exceed 0.08 when tested in accordance with Federal Test Method Standard No. 141, Method 6131.

Application of the baking enamel may be by spray,

roller, or dip, at the option of the manufacturer. Other methods may be used provided they are approved prior to use. The dry film thickness of the baked enamel coating on the galvanized steel plates shall be not less than 2.0 mils on both front and back surfaces. The dry film thickness on both front and back surfaces of the aluminum plates shall be not less than 1.5 mils on each side if enamel is applied by spray or dip method and not less than 1.0 mil if enamel is applied by continuous roller coat method.

The coating shall be uniform throughout and shall be smooth and free from flow lines, streaks, blisters, or other surface imperfections.

The finished plates shall be free from dents and defects. The maximum surface deviation from a horizontal plane on which the finished plate lies shall not exceed 0.25 inch.

721.03.03 Reflectors. (a) Photometric Requirements. Each reflective delineator shall have the following minimum brightness values at two (2) degrees divergence expressed as candlepower per foot candle. Measurements shall be conducted in accordance with standard photometric testing procedures for reflex reflectors of the Society of Automotive Engineers.

Angle of Incidence—	—Silver-White—		—Yellow—	
Divergence Angle	.2	.5	.2	.5
0 Degrees	9.0	3.8	5.3	2.3
15 Degrees	8.0	3.4	4.4	2.0
30 Degrees	5.4	2.9	2.7	1.2
45 Degrees	2.6	1.1	1.0	0.5

The brightness of the reflective sheeting, totally wet by rain, shall not be less than ninety (90) percent of the above values. Wet performance measurements shall be conducted in conformance with standard rainfall tests specified in Military Specification MIL–R–13689A, or as amended.

(b) Durability. The delineator surface may be readily refurbished by cleaning and clear overcoating in accordance with the manufacturer's recommendations.

SECTION 722

WATER

SCOPE

722.01.01 Material Covered. This specification covers the quality of water for use in preparing cement concrete or soil-cement mixtures, and for wetting embankment, backfill, subgrade, and gravel base and surfacing courses.

REQUIREMENTS

722.02.01 General. All water for embankments, backfill, subgrade, gravel base, landscaping, and surface courses and cement concrete curing shall be free from an excessive amount of acids, alkali, oil, and other substances which, in the opinion of the Engineer, will cause damage to the above mentioned items.

PHYSICAL PROPERTIES AND TESTS

722.03.01 Concrete Use. Samples submitted for tests shall each consist of two (2) quarts of water, obtained and shipped in clean glass containers carefully packed and labeled. Tests shall be made in accordance with the current Standard Method of Test for Quality of Water to be Used in Concrete, Test Method No. Nev. T506.

Any indication of unsoundness, marked change in time of setting, or a reduction of more than ten (10) percent in strength from results obtained with concrete mixtures containing the water of satisfactory quality shall be sufficient cause for rejection of the water under tests.

SECTION 723

HARDWARE

SCOPE

723.01.01 Materials Covered. This specification covers the quality of bolts, nuts, washers, drift pins, dowels, nails, spikes, and other metal fastenings.

PHYSICAL PROPERTIES AND TESTS

723.03.01 Galvanizing. Galvanizing, when required, shall meet the current Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware, ASTM Designation A153.

723.03.02 Bolts, Nuts, Dowels, and Drift Bolts. Bolts, nuts, dowels, and drift bolts shall conform to the requirements of the current Specification for Steel Machine Bolts and Nuts and Tap Bolts, ASTM Designation A307, Grade A, unless otherwise specified.

723.03.03 Washers. Cast washers shall be of cast iron of the O-gee type. The diameter shall be not less than three and one-half (3½) times the diameter of the bolts for which it is used. The diameter of the hole shall be one-eighth (⅛) inch larger than the diameter of the bolt.

Flat malleable washers shall be of malleable iron with ribs properly proportioned to develop the full strength of the bolt and, unless otherwise shown on the plans, the diameter shall be not less than three and one-half (3½) times the diameter of the bolt for which it is used and its thickness equal to one-half (½) the diameter of the bolt. The diameter of the hole shall be one-eighth (⅛) inch larger than the diameter of the bolt.

SECTION 724

FENCE MATERIALS

SCOPE

724.01.01 Materials Covered. This specification covers the quality of barbed wire, woven wire, and chain-link fabric fencing, fence posts, gates, and miscellaneous fence hardware.

REQUIREMENTS

724.02.01 Samples and Certificates of Inspection. The Contractor shall supply the Engineer with three (3) line posts for testing purposes, the posts to be selected at random by the Engineer.

Without expense to the Department, two certificates covering each order of material shall be furnished by the manufacturer, certifying that the various metal components comply with the requirements herein. The certificates shall be delivered to the Resident Engineer at the time, or prior to, delivery of the order.

PHYSICAL PROPERTIES AND TESTS

724.03.01 Wood Posts. Intermediate braced posts and braces shall be of the same type as line posts.

End, gate, and corner post assemblies, including bracing timber, shall be sawed and shall conform to the grading requirements of Section 718, "Timber." They shall be of Douglas Fir, Larch, or Southern Pine.

Line posts and intermediate braced posts and bracing shall be round and shall be of Douglas Fir, Southern Pine, Lodge Pole Pine, or Larch manufactured from sound live trees well seasoned and free from large knots, shakes, or splits or other defects which will impair their strength or durability. The posts and braces shall be peeled to remove all outer bark and all inner cambium bark, except an occasional strip of inner bark may remain if not over one-half (½) inch wide or three (3) inches long. All knots shall be trimmed flush with the side, spurs and splinters removed, and ends cut square.

Line posts and intermediate braced posts and braces shall not be less than seven (7) feet long and all other posts and braces shall be not less than eight (8) feet long.

The small end of round line posts and braces shall be between three and one-half (3½) and four and one-half (4½) inches in cross sectional dimension; the small end of intermediate braced posts shall be between five and one-half (5½) and six and one-half (6½) inches in cross sectional dimension. The allowable taper from end to end of round posts and braces shall not exceed one and one-half (1½) inches.

When pressure treated materials have been damaged, or when it has been absolutely necessary to cut or bore into them, after delivery to the job site, all exposed untreated wood shall be carefully field treated with preservative applied either by thorough swabbing or by an approved bolt-hole treater as the Contractor may elect.

724.03.02 Metal Posts. Tubular posts shall be galvanized standard-weight steel pipe conforming to the requirements of the current Standard Specification for Black and Hot-Dipped Zinc (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses, ASTM Designation A120, except that the hydrostatic test will not be required.

The base metal for the manufacture of other steel sections used for posts and braces shall be good commercial quality weldable steel.

Posts and braces shall conform to the following requirements:

Location	Type	Min. Size	Min. Weight Pounds Per Linear Foot
End, corner and pull	Pipe	2.351 O.D.	3.10
Line	Pipe	1.869 O.D.	2.31
	H–Section	1.815	2.66
Braces	Pipe	1.630 O.D.	1.93
	H–Section	1.44	2.16
Gate-single to 6 Ft. or double to 12 Ft., incl.	Pipe	2.351 O.D.	3.10
Gate-single over 6 Ft. to 13 Ft. or double over 12 Ft. to 26 Ft., incl.	Pipe	3.960 O.D.	8.65
Gate-single over 13 Ft. Ft. to 18 Ft., incl.	Pipe	6.599 O.D.	18.02

For Standard Type A Fencing

Location	Type	Min. Size	Min. Weight Pounds Per Linear Foot
End, corner pull and *gate	Pipe	2.351 O.D.	3.10
Line	T or H–Section		1.3
Braces	Pipe	1.630 O.D.	1.93

*Size of gate posts shall be as set forth for chain-link fence (see table).

Line posts for Type A fencing shall be galvanized or painted with anti-corrosive paint. The posts shall be drilled, notched, or studded to facilitate fastening the fence and shall be provided with a suitable anchor plate. Each post shall be furnished with not less than seven (7) galvanized wire clamps.

724.03.03 Barbed Wire. Barbed wire may be either steel or aluminum alloy.

Steel barbed wire shall conform to the requirements of ASTM Designation A121. The coating weight shall be Class 1 unless otherwise specified.

Aluminum alloy barbed wire shall be manufactured of aluminum alloy conforming to ASTM Designation B211, alloy 5052–0 for the line wire and alloy 5052–H 38 for the barbs.

724.03.04 Woven Wire. Woven wire shall conform to the requirements of ASTM A116.

724.03.05 Chain-Link Fabric. Chain-link fabric and required fittings and hardware shall conform to the requirements of AASHO M181.

724.03.06 Staples, Brace Wire, and Nails. Brace wire shall be 8 gage, medium temper, 55,000 to 75,000 psi tensile strength and shall be galvanized in accordance with the requirements specified for barbed wire.

Staples shall be made from No. 9 U.S. Steel Wire Gage Galvanized and shall be of the L-shaped (Strong-Hold) type. The long shank shall be threaded one and three-fourths (1¾) inches long.

724.03.07 Metal Gates. (a) Drive Gates for Standard Fencing. The gate frames shall be constructed of

not less than one (1) inch galvanized standard weight pipe conforming to the dimensions, nominal weights, and galvanizing specified in the current ASTM Designation A53 (hydrostatic test will not be required). Galvanized tubular steel braces shall be placed vertically in each gate, and corner and brace joints shall be so secured that the gate will retain a true rectangular shape.

The wire mesh shall be rectangular mesh or two (2) inch diamond mesh and shall be galvanized in accordance with the requirements herein specified for woven wire fabric.

(b) Drive Gate for Chain-Link Fencing. The gate frame shall be constructed of not less than one and one-half (1½) inch galvanized standard weight pipe conforming to the dimension, nominal weights, and galvanizing specified under the current ASTM Designation A53 (hydrostatic test will not be required). Gate frames shall be cross-trimmed with galvanized three-eighths (⅜) inch adjustable truss rods. The corners of the gate frames shall be fastened together and reinforced with malleable iron fittings designed for the purpose of welding.

Chain-link fence fabric as specified for the fence shall be attached to the gate frame by the use of stretcher bars and tie wires as specified for fence construction, and suitable tension connectors spaced at approximate one (1) foot intervals.

(c) Walk Gates. Unless otherwise specified, walk gates shall be three and one-half (3½) feet wide and of the height corresponding to the adjacent fence.

The gate frame shall be constructed of not less than three-quarters (¾) inch galvanized standard weight pipe conforming to the dimension, nominal weights, and galvanizing specified under the current ASTM Designation A53 (hydrostatic test will not be required).

The gate frame shall be filled with fabric meeting the requirements for fabric as specified herein.

The gate shall be furnished complete with approved hinges, latches, and auxiliary braces as required.

SECTION 725

ELASTOMERIC BEARING PADS

SCOPE

725.01.01 Materials Covered. This specification covers the material in elastomeric bearing pads consisting of neoprene, neoprene and metal, or neoprene and fabric.

REQUIREMENTS

725.02.01 Certificate of Inspection. Elastomeric bearing pad material shall be tested by a reputable testing laboratory, recognized by the State, who shall certify that the material meets these specifications and requirements. The Contractor shall furnish the Department with this certification prior to using the material.

PHYSICAL PROPERTIES AND TESTS

725.03.01 General.

	Grade (Durometer) Requirements		
Original Physical Properties			
Hardness ASTM D2240	50±5	60±5	70±5
Tensile Strength, minimum psi ASTM D412	2,500	2,500	2,500
Elongation at break, minimum percent	400	350	300
Accelerated Tests to Determine Long-Term Aging Characteristics Oven-Aged—70 hrs./212, ASTM D573			
Hardness, points change, maximum	0 to +15	0 to +15	0 to +15
Tensile strength, percent change, maximum	±15	±15	±15
Elongation at break, percent change, maximum	—40	—40	—40
Ozone—1 PPM in air by Volume —20% Strain—100+2 F.— ASTM D1149*			
100 hours	No cracks	No cracks	No cracks
Compression Set—22 hrs./158° F., ASTM D395—Method B			
Percent Maximum	25	25	25

*Samples to be solvent wiped before test to remove any traces of surface impurities.

	Grade (Durometer) Requirements		
Low Temperature Stiffness—ASTM D797			
At—40 F., Young's Modulus, Maximum psi...	10,000	10,000	10,000
Tear Test—ASTM D624—Die "C"			
Pounds/lin. in., minimum....	225	225	225

SECTION 726

ROADSIDE MATERIALS

SCOPE

726.01.01 Materials Covered. This specification covers the materials used in erosion control, landscaping, and irrigation systems.

REQUIREMENTS

726.02.01 Certificates and Samples. (a) Topsoil. The Contractor shall obtain from the State Department of Agriculture, a certificate stating that the area from which the top soil is to be obtained is free from noxious weeds.

Before imported topsoil is brought on the jobsite, a ten (10) pound sample shall be submitted to the Engineer for approval. The sample shall be accompanied by a current report, furnished by the Contractor, from a recognized testing laboratory indicating the particle size, clay content, the ph factor, and electrical conductivity of the sample.

(b) Fertilizer. The fertilizer containers shall have the manufacturer's guaranteed statement of analysis clearly marked, all in accordance with State and Federal laws.

(c) Humus. Before bulk humus is brought to the jobsite, a ten (10) pound sample shall be submitted to the Engineer for approval. The sample shall be accompanied by a current report, furnished by the Contractor, from a recognized testing laboratory indicating the moisture retention capacity, organic matter (based on dry weight), mineral matter (ash), silica (acid insoluable ash), nitrogen (based on dry weight), ph factor, and the amount of Douglas Fir bark.

(d) Plants. All plants shall be first-class nursery grown representatives of their normal species and shall be true to type or name as shown on the plans and shall conform to the American Standard for Nursery Stock, No. 1 grade, American Association of Nurserymen, Inc., latest edition, ASA Spec. Z 60.1 and shall be tagged in accordance with the most recent standard practice recommended by the American Association of Nurserymen and

to the latest edition of Standardized Plant Names, American Joint Committee on Horticultural Nomenclature.

All plants shall comply with Federal and State laws requiring inspection for plant diseases and infestations. Inspection certificates required by law shall accompany each shipment of plants, and certificates shall be delivered to the Engineer. All shipments of pines will be accompanied by certificates for USDA Quarantine No. 63, for White Pine blister rust, and Nevada Quarantine No. 54.05 for European Pine shoot moth.

(e) Seeds. The Contractor shall furnish to the Engineer, duplicate copies of a statement signed by the vendor certifying that each lot of seed has been tested by a recognized seed testing laboratory within six (6) months before the date of delivery on the project.

(f) Irrigation Materials. It shall be the Contractor's responsibility to ascertain that all required tests have been made by qualified testing laboratories as approved by the Department. The Contractor shall furnish the Engineer with a written certification that all required tests have been satisfactorily completed and that materials and fabrication thereof comply with all the requirements.

All materials shall be approved prior to use.

PHYSICAL PROPERTIES AND TESTS

726.03.01 Top Soil. Top soil shall consist of fertile, friable soil of loamy character, and shall contain an amount of organic matter normal to the region. It shall be obtained from well-drained arable land and shall be reasonably free from subsoil, refuse, roots, heavy or stiff clay, stones larger than one (1) inch in largest dimension, coarse sand, sticks, brush, litter, and other deleterious substances. Top soil shall be capable of sustaining healthy plant life.

Requirements for top soil shall be as follows:

Particle Size	⅜ inch Max.
Clay Content	20 percent Max. (by weight)
ph Factor	6.4 to 7.4
Electrical Conductivity	0.5 to 1.0 mmhos. per centimeter of the saturation paste extract

726.03.02 Fertilizer. Fertilizer shall be a standard commercial grade of organic or inorganic fertilizer of the kind and quality specified in the contract documents. It may be separate or in a mixture containing the percentage of total nitrogen, available phosphoric acid and water-soluble potash in the amounts specified. All fertilizers shall be furnished in standard unopened containers with weight, name of plant nutrients and manufacturer's guaranteed statement of analysis clearly marked, all in accordance with State and Federal laws.

Acceptable commercial fertilizer will be specified in one of the following forms:

(a) A dry free-flowing granular fertilizer, suitable for application by agricultural fertilizer spreader.

(b) A soluble fertilizer ground to a fineness that will permit complete suspension of insoluble particles in water, suitable for application by power sprayer.

(c) A granular or pelleted fertilizer, suitable for application by blower equipment.

(d) A non-volatile liquid fertilizer.

726.03.03 Humus. Humus shall be processed, composted, fine ground bark of White Fir, Pine, or Redwood, or a mixture of these in any proportion. Humus shall be free of lumps and/or clods and shall be fine enough so that one hundred (100) percent of the material will pass a one-half (½) inch screen, and eighty-five (85) percent will pass a No. 6 screen.

Requirements for humus shall be as follows:

Moisture retention capacity	35 Percent Min.
Organic matter based on dry weight	95 Percent Min.
Mineral Matter (ash)	5 Percent Max.
Silica (acid insoluable ash)	3 Percent Max.
Nitrogen based on dry weight	0.8 Percent Min.
ph Value based on 1:5 solution	4.0 to 6.0 Max.
Douglas Fir Bark	0 Percent

726.03.04 Mulch. (a) Hay or Straw. All hay or straw mulch materials shall be in an air-dried condition free of noxious weeds, weed seeds, and other materials detrimental to plant life. Unless otherwise specified in the

contract documents, hay or straw mulch material shall be of approved field grasses indigenous to the area.

(b) Wood Cellulose Fiber. Wood cellulose fiber mulch shall be specially processed wood fiber containing no growth or germination inhibiting factors and shall be dyed a suitable color to facilitate inspection of the placement of the material.

(c) Wood Chips and Shavings. Shavings shall be manufactured from any clean soft wood.

Wood chips shall be manufactured from any clean, green softwood. Chips from kiln-dried or air-dried material will not be accepted. Chips shall be produced by machinery equipped with knives or blades which cut rather than shred or break the material. Chips shall be graded so that substantially all chips are from one-half (½) inch to three (3) inches in length, one-half (½) inch to one and one-half (1½) inches in width and from one-eighth (⅛) inch to one-half (½) inch in thickness.

Chips produced from tree trimmings which contain leaves or small twigs will not be accepted.

726.03.05 Jute Matting. Jute matting shall be of a uniform open plain weave of undyed and unbleached single jute yarn. The yarn shall be of a loosely twisted construction and shall not vary in thickness by more than one-half its normal diameter. Jute matting shall be furnished in rolled strips as follows:

(a) Length approximately fifty (50) yards.

(b) Matting width shall be forty-eight (48) inches with an average weight of ninety-two hundredths (0.92) pounds per square yard. A tolerance of plus or minus one (1) inch in width and five (5) percent in weight will be allowed.

726.03.06 Plants. All plants shall be first-class nursery grown representatives of their normal species and shall be true to type or name as shown on the plans and shall conform to the American Standard for Nursery Stock, No. 1 grade, American Association of Nurserymen, Inc., latest edition, ASA Spec. Z 60.1 and shall be

tagged in accordance with the most recent standard practice recommended by the American Association of Nurserymen and to the latest edition of Standardized Plant Names, American Joint Committee on Horticultural Nomenclature.

726.03.07 Seeds. Grasses, legumes, or cover crop seed shall be furnished in standard containers on which shall be shown the following information:

(a) Seed name.
(b) Lot number.
(c) Net weight.
(d) Percentage of purity.
(e) Percentage of germination (in case of legumes percentage of germination to include hard seed).
(f) Percentage of weed seed content and inert material clearly marked for each kind of seed in accordance with applicable State and Federal laws.
(g) No noxious weed seed present.

Seed which has become wet, moldy or otherwise damaged in transit or storage will not be accepted. Seed shall be at least ninety-five (95) percent pure and shall have a minimum of eighty-five (85) percent germination.

726.03.08 Tree Ties. Tree ties shall be strips of vinyl coated nylon, durable, non-hardening long-life material approximately one (1) inch wide and approximately ten (10) mils thick, or other suitable material approved by the Engineer.

A number 10-gage galvanized wire encased in at least one-half (½) inch black rubber hose may be used when permitted by the Engineer.

726.03.09 Pipe and Fittings. Pipe shall be standard weight, hot dipped galvanized iron or steel pipe, threaded and coupled. Pipe shall meet the current requirements of ASTM Designation A120, and shall be furnished in standard lengths. All pipe fittings shall be standard threaded galvanized malleable iron fittings.

726.03.10 Control Tubing. Control tubing shall be copper refrigerator tubing meeting the current requirements of ASTM Designation B280 in the size specified on the plans.

726.03.11 Gate Valves. Gate valves, when called for on the plans, shall be heavy duty bronze conforming to the requirements of ASTM Designation B62.

726.03.12 Quick Coupler Valves. Quick coupler valves shall have a service rating not less than 150 psi for non-shock cold water. Body of the valves shall be a single piece construction of cast leaded semi-red brass alloy No. 5–A as given in ASTM Designation B145.

726.03.13 Masonry. Concrete masonry blocks shall conform to the requirements of ASTM Designation C 129.

INDEX OF SUBJECTS

A

PAGE

Abandoned pipe lines 111
Abbreviations 1–2
Abutments, backfill for 149
Abutting joints:
  Reinforced concrete pipe 446
  Steel structures 394
Acceptance and final payment 41, 100–101
Accommodations for public traffic (See also Maintenance of Traffic) 623–627
  Barricades and warning signs 629–639
  Construction methods 623–626
  Description 623
  Equipment rental 626, 627
  Flagmen 624–625, 626, 627
  Maintain base 625, 626
  Materials 623
  Measurement 626
  Payment 626–627
  Pilot cars 625, 626, 627
  Special detours 623–624, 626–627
Additives, fertilizers and 180
Adjustment: (See also Delays in completion of work; Extension of contract time)
  For additional compensation 41–42
  Of common carrier rates 96
Admixtures:
  Air-entraining 654
  Concrete curing materials and 653–654
  Lightweight concrete 369
  Other than air-entraining 654
  Portland cement concrete 310–312
Advertisement, defined 2
Agencies, federal 56
Aggregates (see also sections covering various items of work)
Aggregate base courses:
  Class A aggregates 201–203, 204
    Spreading 201–203
    Tolerance for Type 2 204
    Watering and mixing 203
  Class B aggregates 202–203
    Spreading 202–203
    Watering 203

	PAGE
Aggregate base courses—*continued*	
Compaction	203–204
Construction methods	201–204
Description	201
Materials	201
Measurement	204–205
Payment	205
Subgrade preparation	201
Watering	203
Aggregates, base:	
Deficiencies	671
General requirements	671
Grading requirements, tables	672–674
Drain backfill	672
Type I, Class A	672
Type I, Class B	673
Type II, Class A	673
Type II, Class B	673
Type III, Class A	674
Type III, Class B	674
Physical properties and tests	672–674
Plastic limits	671–672
Aggregates, bituminous courses:	
Commercial mineral filler	677
Deficiencies	675
General requirements	675
Materials covered	675
Physical properties and tests	675–678
Plantmix bituminous open-graded surface	677
Plantmix and roadmix bituminous base and surface, Types 1, 2 and 3	675–676
Plantmix surface, Type 4	676–677
Sand blotter	678
Screenings	677–678
Aggregates, portland cement products:	
Coarse, requirements for	679–681
Fine, requirements for	309–310, 682–683
General requirements	679
Grout and mortar sand, requirements	683–684
Handling of	53
Lightweight, requirements tables	681–682
Lightweight, storage of	372
Stone for masonry and riprap	684
Aggregates, portland cement treated base:	
Requirement tables	674
Sampling of base courses	49
Aggregate spreader, for surface treatment	273

	PAGE
Agreement:	
With owner of source materials	46
Supplemental	9, 23–24
Air-entraining admixtures	654
Portland cement concrete	309, 310–312
Alterations:	
Contract	23–25
Staging or sequence of operations	27
Altered quantities	23–25, 42
Aluminum alloy:	
Barbed wire	729
Bolts for signs	708
Bridge rail, used in	693
Fabrication and handling of	384
For pipe	693
For shims	693
For tubing	693
Aluminum sheets:	
Culvert markers and guide posts	719–720
Guardrail construction	717
Permanent signs	641–643
Sign panels	708–709
American Association of Nurserymen	1
American Association of State Highway Officials	1
American Concrete Institute	1
American Institute of Architects	1
American Institute of Steel Construction	1
American Railway Association	1
American Railway Engineering Association	1
American Society of Civil Engineers	1
American Society of Landscape Architects	1
American Society of Mechanical Engineers	1
American Society for Testing and Materials	1, 533
American Standards Association	1
American Water Works Association	1
American Welding Society	1
American Wire Gage	1, 533
American Wood Preservers Institute	1
Ammoniacal copper arsenite	505
Anchor assemblies:	
Concrete reinforcement	699
For downdrains	469
Anchor bolts:	
For rail posts	405
For signs	708–709
Anchorages:	
And distribution plates, prestressed concrete members	361–362
Prestressing reinforcement and, testing	698–699
Angles, end connection	395

INDEX

PAGE

Anionic emulsified asphalts, specifications table 668
Annealing and stress relieving, steel structures 403
Annulment of award 21
Aprons, concrete 483–485
Archeological and paleontological objects, preservation of 64–65
Artifacts, preservation of 64–65
Asbestos bonded bituminous coated pipe 689
Asphalt cement:
  Average weights and volumes tables 90
  Demerits schedule 660
  Requirements 656–660
  Road materials, specifications table 658–659
Asphalt emulsions:
  Anionic, specifications table for 668–669
  Cationic, specifications table for 666–667
  Measurement 89
  For mulch 162, 165
Asphalt for waterproofing and dampproofing 655
Assembly:
  Field 407–408
  Metal bin-type retaining walls 488–489
  Shop 392–393
  Structural plate pipe 460
Assignees (see Subcontractors)
Assignment of contract 73–74
Associated General Contractors of America 1
Association of American Railroads 1
Authority and duties of:
  Engineer 31, 82
  Inspector 36
  Resident Engineer 36
Automatic controllers, irrigation systems 185–186
Average weights and volumes tables:
  Asphalt cement 90
  Asphaltic emulsion 90
  Liquid asphalt 90
Award:
  Annulment of 21
  Cancellation of 19–20
  Of contract 19
  Defined 2
  And execution of contract 19–21
  Notice of 19

B

Backfill:
  Abutments 149
  At culverts 149–150

Backfill—*continued* PAGE
Compaction ... 148
Construction methods ... 148–150
Defined ... 147
Description ... 147
Drain (see Drain Backfill)
With excavated materials ... 111, 144
Granular ... 147
Of holes ... 111
For irrigation systems ... 195
Materials ... 147–148
Measurement ... 150
Payment ... 150–151
Pits ... 111
Placing and compacting:
Abutments, piers, wingwalls and retaining walls ... 149
Bin-type retaining walls ... 150
Culverts ... 149–150
Water for ... 723
Backflow preventers, irrigation systems ... 188, 192
Bar steel reinforcement for concrete ... 697
Barbed wire ... 511, 729
Barrel of cement, defined ... 89
Barricades and warning signs ... 58, 629–639
Partial payments on ... 99–100
Temporary signs ... 635–639
Bars:
Extruded in-place, traffic separator ... 531–532
Galvanizing of ... 705
High-tensile-strength alloy ... 698
Lacing, for steel structures ... 395
Precast, traffic separator ... 531–532
Raised traffic ... 531–532, 703
For signs ... 708
Base courses, aggregates used in ... 49–51, 201–205, 671–674
Base or surface selected material, (see Selected Material)
Basements left by structure removal, backfill and compaction of ... 111
Bases: (see sections for various items of work)
Basis of payment clause (see also sections for various items of work) ... 93
Batching plants for:
Bituminous plantmix pavements ... 227–232
Portland cement concrete pavement ... 282–285
Bearing devices, concrete structures ... 348–349
Bearing plates, steel structures ... 406
Galvanizing of ... 707
Bearing surfaces, steel structures ... 394
Bearing value and penetration of piles ... 423–424

INDEX

PAGE

Bearing and anchorage, steel structures....406–407
Beginning of work....227–230
Steel mills.... 382
Bending reinforcing steel....377, 378
Bidders:
Award of contract (see also Award).... 19
Bond....3, 20
Collusion among....17, 19
Defined.... 2
Disqualification of.... 17
Examination of plans....13–14
Financial statement of.... 11
Licensing of.... 12
Material guaranty by.... 17
Notice to contractor.... 11
Prequalification of....11–12
Proposal (see Proposal)
Bidding requirements and conditions....11–18
Bids (see also Bidders; Contractor; Proposal)
Combination or conditional....17–18
Irregular.... 15
Rejection of.... 17
Bituminous binders, pay quantities....89–90
Bituminous courses, aggregates for....675–678
Bituminous materials....655–669
Asphalt cements....656–660
Demerit schedule.... 660
Contractor's responsibility for.... 655
Emulsified asphalt....664–669
Anionic emulsified asphalts.... 668
Cationic asphalt emulsions....666–667
Demerit schedule.... 669
Liquid asphalts....660–664
Demerit schedule.... 664
Physical properties and tests....656–669
Preparation of.... 236
For prime coat....265, 266–267
Refinery test report.... 656
Schedule of liquidated damages.... 94
For seal coat....269, 270
Shipping notice.... 655
For surface treatment....273, 275
For tack coat....261, 262
Waterproofing and dampproofing, asphalt for.... 655
Bituminous mixing plant requirements....227–234
For all plants....228–230
For batching plants....230–232
For continuous mixing plants....232–234
Safety.... 230

	PAGE
Bituminous mixtures:	
Downdrains	470
Hauling equipment for	234
Bituminous open-graded plantmix surface:	
Aggregates for	677
Construction methods	247–248
Description	247
Joints	247
Materials	247
Measurement	248
Payment	248–249
Rollers	247
Surface tolerances	248
Weather limitations	236
Bituminous pavement, removal of	112
Bituminous pavers	234–235
Bituminous plantmix base:	
Aggregate requirements	675–676
Construction methods	207–208
Description	207
Materials	207
Measurement	208
Payment	208–209
Rollers	207
Spreading and finishing	208
Surface tolerances	208
Weather limitations	236
Bituminous plantmix mixtures, composition of	225–227
Bituminous plantmix pavements (see Pavements, plantmix bituminous)	
Bituminous plantmix surface:	
Aggregates for	675–677
Construction methods	243–244
Description	243
Materials	243
Measurement	244
Payment	245
Rollers	243
Spreading and finishing	244
Surface tolerances	244
Weather limitations	236
Bituminous roadmix base, aggregates for	675–676
Bituminous roadmix surface:	
Aggregates for	251, 253, 675–676
Application of bituminous materials	254
Bituminous materials	251–252, 254
Construction methods	252–258
Description	251
Distributors	252
Existing surface, preparation of	253

Bituminous roadmix surface—*continued* PAGE
Materials....251–252
Measurement....258–259
Miscellaneous areas....257–258
Mixing....254–256
Mixing plants.... 252
Motor graders.... 252
Payment....259–260
Placing aggregates.... 253
Rollers.... 252
Spreading, compacting and finishing....256–257
Surface preparation.... 253
Surface tolerances.... 258
Weather limitations.... 252
Bituminous surface, existing (see Existing Surfaces)
Blasting for:
Excavation.... 119
Removal of existing structure.... 112
Blotter material (see Sand Blotter)
Bolts and bolted connections, steel structures....387–392
Bolt lengths, table.... 389
Bolt tension, table.... 391
High-tensile strength.... 691
Nuts, dowels and drift bolts.... 725
Nuts and washers, galvanizing of.... 705
Guardrail materials....717, 718
For signs.... 708
Stainless steel.... 691
Structural plate pipe....458–459
Turn-of-nut method.... 392
Washer dimensions, table.... 390
Bolts and washers, timber structures.... 413
Bonded grout finish, concrete structures....352–354
Bonds, contract....3, 20
Labor and material.... 20
Surety....9, 20
Borrow:
Contract agreement.... 123
Excavation and embankment....118, 123–124
Overhaul....124, 141–142
Boxes, planter....172–173
Boxes, valve, irrigation systems.... 188
Brace wire, fence material.... 729
Braces for:
Fence materials....727, 728–729
Signs.... 708
Timber structures....414–415
Bridge:
Defined.... 2

Bridge—*continued* PAGE
Length, defined 2
Rail, aluminum for 693
Railings, paint for 701–703
Roadway width, defined 2–3
Bridges, concrete (see also Concrete Structures)
Extensions of existing 112
Load and speed restrictions on new 38–40
Placing portland cement concrete in 333
Railing, aluminum for 693
Removal of 111–112
Steel (see Steel structures)
Timber (see Timber structures)
Bronze castings 695
Bronze disks for monuments 529
Brush, removal of 107, 108
Buildings, removal and disposal of 111–116
Bureau of Public Roads—Department of Transportation 1
Manual on Uniform Traffic Control Devices 2
Burning regulations 66–67

C

Calcium chloride 654
Calendar day, defined 3
Caps, timber structures 414
Carbon steel structural tubing 691
Cast aluminum alloy 693
Cast-in-place concrete piles 420, 428–430
Castings:
Bronze 695
Gray Iron 695
Iron and steel, painting of 502
Malleable 695
Steel 695
Catch basins, manholes and inlets:
Adjusting of covers 474, 475
Clean out 474
Construction methods 473–474
Covers, concrete 474
Description 473
Earthwork 474
Grates 473–474, 475
Materials 473
Measurement 474–475
Payment 475–476
Pipe or tile used in 474
Removal of 112

	PAGE
Cattle guards:	
Construction methods	515–516
Description	515
Earthwork	515
Materials	515
Measurement	516
Paint for cattle guard wings	702–703
Painting	516
Payment	516–517
Wings	515–517, 702–703
Cavities left by structure removal	111
Cement measurement	89
Cement, protecting and sampling	315–316
Cement treated base:	
Aggregates for	674
Compaction	218
Construction joints	219–220
Construction methods	211–221
Curing, protection and	220–221
Description	211
Finished surface	218–219
Materials	211
Measurement	89, 221–223
Plantmix method	222
Roadmix method	221
Mixing:	
Plantmix method	213–216
Roadmix method	211–213
Payment	223–224
Plantmix method	223–224
Roadmix method	223
Proportioning	211
Protection and curing	220–221
Requirements, portland cement	651
Spreading	216–218
Time requirements	219
Watering	157–159, 218
Weather limitations	221
Cement treated subgrade	651
"Low alkali cement" used in	651
Certificates:	
Of compliance	51
Culvert markers and guide posts	719
Elastomeric bearing pads	731
Fence materials	727
Guardrail materials	717
Paint	701
Roadside material	733–734
Sign materials	707
Timber	713

PAGE
Chain-link fencing....509–514
Drive gate for.... 730
Fabric.... 729
Change order....3, 24–25, 94–96
Changes in character of work....23–25
Channel, defined.... 3
Channel excavation (see Ditch and channel excavation)
Character of workmen; methods and equipment....76–77
Chief engineer (railroad), defined.... 58
Chipping, reaming and cutting.... 408
Cited specifications....51–52
Claims for adjustment and disputes....41–42
Classification and proportions:
Lightweight concrete....372–373
Portland cement concrete....316–317
Clearance markers, railroad.... 59
Clearing and grubbing:
Areas to be cleared....105–106
Construction methods....105–107
Disposal locations....106–107
Measurement....107–108
Payment....108–109
Scalping.... 107
Structure excavation material....144, 146
Coarse aggregates for portland cement concrete....310, 679–682
Cofferdams, concrete structures....338–339
Seal course of concrete under water....343–344
Structure excavation.... 143
Cold-formed carbon steel structural tubing....691–692
Collusion among bidders....17, 19
Columns, concrete structures....342–343
Combination bids....17–18
Commencement of work....74–75
Preconstruction conference.... 79
Commercial mineral filler.... 677
Common carrier rate adjustments....96–97
Compaction: (see also Rollers and rolling)
Aggregate base courses....203–204
Backfill....148–150
Basements and cavities left by structure removal.... 111
Bituminous roadmix surface....256–257
Concrete placed in concrete structures....340–341
Dirt embankment....128–129
Embankment....111, 128–134
Erosion control.... 163
Foundation areas, watering of....157–159
Foundation fill.... 153
Portland cement concrete pavement....290–292
Portland cement treated base.... 218

Compaction—*continued* PAGE
Rock embankment....129–134
Selected material.... 198
Top soil, erosion control.... 163
Compactors, excavation and embankment (see also Rollers and rolling)
Pneumatic tired....131–133
Sheepsfoot....130–131
Vibratory.... 133
Completion of work....68, 82
Failure to complete on time....80–81
Termination of contractor's liability.... 82
Compliance, certificate of.... 51
Concrete:
Cutoff walls, slope paving....483–485
Deposited under water....343–344
End posts, paint for.... 703
Handling and placing....339–343
Making properties:
Lightweight concrete....369–370
Portland cement concrete....312–314
Members, prestressed (see Prestressed concrete members)
Mixers....321–326
Mixing....288–289, 321–326, 339
On-site mixed....322–323
Pavements:
Portland cement (see Pavements, portland cement concrete)
Removal of.... 112
Piles:
Cast-in-place....420, 428–430
Precast....420, 422, 427–428
Portland cement (see Portland cement concrete)
Prestressed (see Prestressed concrete members)
Properties and tests.... 280
Ready-mixed....323–326
Reinforcement.... 338
Materials....697–699
Removal and disposal of....114–115
Concrete curbs, gutters and sidewalks....491–496
Concrete curing materials and admixtures....653–654
Admixtures other than air-entraining.... 654
Air-entraining admixtures.... 654
Calcium chloride.... 654
Hydrated lime.... 654
Subgrade paper.... 654
Water for.... 723
Concrete slope paving and aprons:
Construction methods....483–484

Concrete slope paving and aprons—*continued* PAGE
Cutoff walls 483
Description 483
Earthwork 483
Expansion joints 484
Materials 483
Measurement 484
Payment 484–485
Concrete structures 333–357
Aprons (see Concrete slope paving and aprons)
Bearing devices 348–349
Bonded grout finish 352–354
Catch basins (see Catch basins, manholes and inlets)
Centering, falsework or 337–338
Cofferdams and cribs 338–339
Compaction by mechanical vibration 340–341
Concrete deposited under water 343–344
Construction joints 344–346
Construction methods 333–355
Culverts (see also Culverts) 342
Curbs, gutters and sidewalks (see Curbs, gutters and sidewalks) 491–496
Curing 349
Depth of footings 333
Description 333
Elastomeric bearing pads 349
Expansion and fixed joints and bearings 347–349
Falsework 335, 337–338
Removal of 346–347
Filled joints 347
Fine surfaces 351–354
Finishing 350–354
Formed surfaces requiring finishing 351
Forms 333–337
Corrugated metal 337
Plywood 336–337
Removal of 346–347
In vicinity of railroads 335
Girders, slabs and columns 342–343
Handling and placing concrete 339–343
Horizontal surfaces, finish of 350–351
Joints 344–349
Lightweight concrete (see Lightweight concrete for structures)
Live loads 354–355
Load restrictions 354–355
Materials 333
Measurement 355–356
Mixing concrete 339

Concrete structures—*continued*
Monuments (see Monuments) PAGE
Open joints 347
Ordinary surface finish 351
Patching 350
Payment 356–357
Piles 427–430
Placing concrete 339–343
Culverts 342
Girders, slabs and columns 342
Pumping concrete 343
Pumping water 339
Reinforcement 338
Removal of falsework, forms and housing 346–347
Rubbed finish 352
Slope paving (see Concrete slope paving and aprons)
Steel joints 347–348
Traffic bars (see Traffic bars)
Tremie or underwater bottom dump bucket 343–344
Vibrators, provisions for 340–341
Waterstops 348
Concrete surface, existing (see Existing surfaces)
Concrete tests, properties and 280
Concrete use items, paint for 703
Conditional bids 17–18
Conditions of employment, wages and 103
Conduit:
Irrigation systems 192, 193
Perforated metal pipe for 689
Conference, preconstruction 79
Connection angles, steel structures 395
Construction:
Joints, cement treated base 219
Joints, concrete structures 344–346
Load and speed restrictions 38–40
Maintenance during 40
Signs (see also Signs, construction) 99, 629–633
Stakes, lines and grades 35–36
Contact joints, portland cement concrete pavement 293
Contract:
Alterations 23–25
Assignment of 73–74
Award and execution of 19–21
Bond 20
Completion 68
Default and termination of 81–82
Defined 3
Execution and approval of 21

Contract—*continued* PAGE
Failure to execute....21, 31, 81–82
Increased or decreased quantities....23–25, 42
Intent of.... 23
Items, defined.... 3
Modification.... 32
Proposal forms for examination of....13–14
"Specialty items".... 74
Subletting of....73–74
Termination of.... 68
Time:
Commencement of....74, 80
Completion of.... 68
Defined.... 4
Determination and extension of....79–80
Failure to complete work on....80–81
Contractor:
Change in operations.... 27
Conformity of, with plans and specifications.... 32
Cooperation by....33–34
Between contractors.... 35
With utilities.... 34
Default and termination of contract....81–82
Defined.... 3
Delays in completion of work (see Delays)
Equipment....76–77
Failure to execute work....31, 81–82
Fair Labor Standards Act, observation of.... 56
Financial statement of.... 11
Legal rights, no waiver of....71–72
Licensing of.... 55
Limitation of operations.... 75
Methods....76–77
Notice.... 11
Notice to proceed.... 74
Defined.... 6
Payments to....92–94
Acceptance and final....100–101
"Extra and force account"....94–96
Partial....97–100
Permits, licenses and taxes.... 55
Plans and working drawings of....31–32
Prequalification of....11–12
Prosecution and progress of contract....73–83
Public liability and property damage insurance.... 61
Railroad's insurance....61–62
Relations with railroads....58–62, 335

Contractor—*continued* PAGE
Relief from maintenance and responsibility....68–69, 82
Responsibility for: (see also Legal relations and responsibility)
Archeological and paleontological objects, protection of....64–65
Artifacts, preservation of....65
Bituminous materials, quality of....655
Claims for materials, supplies and labor....64
Claims against subcontractor....64, 73
Defective work....64
Explosives, use of....62–63
Hauling equipment, damage caused by....38–40
Landscape, protection and restoration of....64–66
Materials, supplies and labor....64, 69
Public convenience and safety....57–58
For sanitary conditions....57
State furnished materials....54
Supplies....64
Surfaces opened by permit....56
During suspension of work....79
Termination of....82
Utility properties, protection and restoration of....56, 64–66, 70–71
Work and materials....64, 69
Supplemental agreement....9, 23–25
Working drawings....10, 31–32
Workmen's compensation....63
Control, of material....43–54
Tubing, irrigation systems....185, 191
Copper....191
Installation of....194
Materials requirements....738
Valves....187
Of work....31–42
Conversion tables from gallons to weight....90
Conveyor scales....88
Coordination of plans, specifications, supplemental specifications, and special provisions....33
Copyright....55
Core materials, signs....709
Corner posts....512
Covers, catch basins, manholes and inlets....474–475
Cribs, concrete structures....338–339
Structure excavation....143
Culvert, defined....4
Culvert markers and guide posts....525–526, 719–721
Certificates....719
Construction methods....525

Culvert markers and guide posts—*continued* PAGE
Description 525
Measurement 525
Metal posts 719
Payment 526
Reflectors 525, 721
Removal and disposal of 111
For reuse 113
Reset 525
Target members 525
Target plates 719–721
Timber, quality requirements of 713
Culvert pipes (see Culverts)
Culverts:
Aluminum corrugated metal pipe and aluminum arch
Construction methods 455
Description 455
Materials 455
Measurement 455
Payment 455–456
Quality requirements 690
For underdrains 465
Backfill 149–150
Bituminous fiber pipe for 687
Clay pipe for 687
Closing of 113
Concrete and clay pipe and drains for 687–688
Concrete structures 342
Corrugated metal pipe and metal arch pipe
Construction methods 451–453
Description 451
For downdrains 690
Elliptical pipe 451
Laying culvert pipe 452
Materials 451
Measurement 454
Payment 454
Relay culvert pipes 453
Siphons 452–453
Strutting 452
For underdrains 690
Extensions of existing culverts 437–438
Removal of 112–113
Structural plate pipe and pipe arch culverts 462
Laying culvert pipes 437
Corrugated metal pipe and metal arch pipe 452
Reinforced concrete 445–447
Non-reinforced concrete pipe for (see also Pipes) 441–442, 687

Culverts—*continued* PAGE
Perforated bituminous fiber pipe for 688
Perforated metal pipe for 689
Pipe culverts—general:
Construction methods 436–438
Description 435
Earthwork 436
End sections 436
End walls 436
Extension of existing culverts 437–438
General requirements 435–440
Headwalls 436
Inspection of materials 435
Jacked pipes 437
Laying pipe 437
Materials 435–436
Measurement 438–439
Payment 439–440
Water encountered on site 439
Placing concrete in 334, 342
Reinforced concrete pipe for (see also Pipes) 443–449, 687
Relay culvert pipes 453
Removal of culverts 111–113
Structural plate pipe and pipe arch culverts
Assembly 460
Bolts 458–459
Construction methods 458–462
Description 457
Earthwork 459–460
Extension of existing 462
Field inspection 459
Headwalls 462
Materials 457–458
Measurement 462–463
Payment 463
Plates 457–459
Quality requirements 690
Salvaged, reinstallation of 457
Strutting 461
Water encountered at site 463
Workmanship 461
Curbs, gutters and sidewalks:
Construction methods 491–495
Curb and gutter joints 492–493
Description 491
Earthwork 491
Forms 492
Materials 491
Measurement 495–496

Curbs, gutters and sidewalks—*continued* PAGE
Payment ... 496
Reconstruction of existing ... 491–492
Removal of ... 112
Sidewalk construction ... 495
Sidewalk expansion joints ... 493
Curing:
Cement concrete, water for ... 723
Cement treated base ... 220–221
Formed concrete ... 349
Liquid asphalt materials ... 660–664
Materials and admixtures, concrete ... 653–654
Curing portland cement concrete ... 326–328
Compound method ... 327
Form method ... 328
Pavement ... 300
Under water ... 344
Water method ... 327
Waterproof paper method ... 328
Curing prestressed concrete members ... 366
Cut-out letters, numerals, symbols and accessories:
Permanent signs ... 646–648
Temporary signs ... 636–637
Cuts, widening ... 120
Measurement and payment for ... 136

D

Damage claims, contractor's responsibility for ... 63–64
Dampproofing ... 655
Day, calendar, defined ... 3
Day, work, defined ... 9
Decreased quantities, increased or ... 23–25, 42
Default and termination of contract ... 81–82
Defective materials, contractor's responsibility for ... 69
Defective work, contractor's responsibility for ... 64, 69
Definitions and terms ... 1–10
Delays in completion of work ... 80–81
Due to cooperation with utilities ... 34–35
Due to preservation of artifacts and archeological and paleontological objects ... 65
Due to restoration of surfaces opened by permit ... 56
Right of way ... 82–83
Department, defined ... 4
Department furnished material ... 54
Department of Highways testing methods ... 51–52
Determination and extension of contract time ... 79–80, 83
Detour, defined ... 4

PAGE
Detour, special....623–624, 626
Detours, arrangements for....26–28, 75, 631
Dewatering, structure excavation....143
Directors, defined....4
Dirt embankment, compaction of....128–129
Disposal of materials (see also Removal)
Clearing and grubbing....106–107
Excavated....114
Non-perishable....111
Outside highway right of way....67–68, 111
Structure excavation materials....144
Disqualification of bidders....17
Distribution plates or assemblies, anchorage and....361–362
Testing prestressing anchorages....698
Distributors for bituminous roadmix surface....252
Ditch and channel excavation....117–118
Overhaul on....141–142
Ditch and dike areas, roads in....66
Divided highway, defined....4
Downdrains....469–472
Anchor assembly....470
Bituminous mixtures and grouted riprap....470
Construction methods....469–470
Corrugated metal pipes for....471, 690
Description....469
Embankment protectors....470, 471
Materials....469
Measurement....470–471
Metal....469–470
Payment....471–472
Riprap....470
Drain backfill:
Aggregates for....672
Construction methods....155
Measurement....155
Payment....156
Around underdrains....155, 465
Drain valves, irrigation systems....188
Drainage:
Downdrains....469–472
Excavation....117
During roadway construction....122–123
Structures, perforated metal pipe for....689
Structures, removal of....111
Drains, concrete and clay pipe for....687–688
Metal pipe for....689–690
Drawings, working....10
Plan and....31–32

Drawings, working—*continued* PAGE
Signals and lighting....534–535
Steel structures....381–382
Driving of piles....421–423
Equipment....420–421
Dust, control by watering....157–159
Nuisance.... 72

E

Earthwork:
Bin-type retaining walls.... 488
Catch basins, manholes and inlets.... 474
Cattle guards.... 515
Concrete curbs, gutters and sidewalks.... 491
Concrete slope paving.... 483
Pipe culverts—general.... 436
Reinforced concrete pipe....444–445
Riprap.... 478
Structural plate pipe....459–460
Underdrains.... 466
Edge planing, steel plates.... 393
Elastomeric bearing pads....349, 407
Certificate of inspection.... 731
Material requirements....731–732
Physical properties and tests....731–732
Electronic Industries Association....2, 533
Eliminated items, from contract.... 96
Elliptical:
Concrete pipe, reinforced.... 447
Corrugated metal pipe.... 452
Embankment (see also Earthwork)
Construction with excavated materials.... 114
Dirt, compaction of....128–129
Excavation and (see also Excavation and embankment)....117–138
Foundation areas.... 125
Watering....157–159
Maintenance.... 134
Material....125–126
Pipe installation in new....444–445
Placing....126–128
Protectors; downdrains....469–472
Rock, compaction of....129–134
Against structures.... 126
Water for wetting of.... 723
Employee, defined (see also Workmen).... 4
Employment, wages and conditions of.... 103

PAGE
Emulsions, asphaltic....664–669
Anionic specifications table.... 668
Average weights and volumes table.... 90
Cationic specifications table....666–667
Used in mulch.... 162
Enclosures for prestressing steel.... 362
End:
Connection angles, steel structures.... 395
Corner and gate posts.... 512
Posts, concrete, paint for.... 703
Sections, pipe culverts....436, 689
Stiffeners, steel girders.... 402
Engineer:
Authority of....31, 82
Decisions of.... 31
Defined.... 4
Inspection by....36–37
Resident, authority and duties of.... 36
Equipment (see also Compactors; Rollers; Truck mixers; Vibrators)
Concrete structure construction....340–341
Defined.... 4
Excavation and embankment....130–133
"Equipment hours".... 27
Methods and....76–77
Pile driving....420–421
Portland cement concrete construction....315, 323–325
Rental....90–92, 626
Steel structure construction....404–405
Erection methods, steel structures....404–405
Erosion control (see also Roadside materials)
Compaction of top soil.... 163
Construction methods....162–163
Contractor's responsibility.... 66
Cultivation.... 162
Description.... 161
Fertilizer.... 161
Jute matting....165–166
Materials....161–162, 733–738
Measurement.... 166
Mulch....161–162, 165
Payment.... 167
Seed.... 161
Seeding and fertilizing....163–164
Top soil....161, 162–163
Excavation and backfilling of removed structures.... 111
Excavation and embankment:
Blasting.... 119

Excavation and embankment—*continued* PAGE
Borrow....118, 123–124
Overhaul on.... 124
Channel excavation....117–118, 123
Compaction:
Construction methods....128–134
Dirt embankment....128–129
Equipment....130–133
Rock embankment....129–134
Testing by construction methods and equipment..129–134
Construction methods....118–134
Description.... 117
Drainage during construction of roadway....122–123
Drainage excavation materials.... 117
Foundations for.... 125
Maintenance.... 134
Materials....117–118, 125–126
Measurement....134–137
Overbreak.... 120
Payment....137–138
Placing embankment....126–128
Roadway excavation....117, 118
Rock cuts....119–120
Rock materials.... 128
Selected material....121–122
Slides and slipouts.... 122
Slopes.... 120
Surplus material....120–121
Unsuitable material....118–119
Removal of.... 119
Widening cuts.... 120
Excavation, structure....143–146
Excavation, adjacent to trees....190–191
Execution of contract, award and....19–21
Expansion and fixed joints and bearings....347–349
Explosives, use of....62–63
Extension:
Of contract time....65, 79–80, 83
Of existing culverts and bridges....112–113
Of existing culverts, structural plate pipe and pipe arch.... 462
Extra and force account work....94–96
Idle time of equipment.... 83
Right-of-way delays....82–83
"Extra work".... 25
Defined.... 5
Extruded traffic bars....531–532
Eyebar steel....691–692

F

PAGE

Fabricated steel bar reinforcement 697
Facilities, utility (see Utility property and services)
Facing of bearing surfaces, steel structures 394
Failure:
  To carry on work in acceptable manner 81
  To complete work on time 80–81
  To execute contract 21
  To maintain roadway or structure 40–41
Fair Labor Standards Act 56–57
Falsework, concrete structures 335, 337–338
  Removal of 346–347
Falsework, steel structures 405–406
Fastenings (hardware), galvanizing of 705
Federal agencies, approval of work 56–57
Federal aid projects:
  Bidders requirements 12
  Inspection by Federal agencies 56
Federal Specifications and Standards, General Services Admin 2
Fence materials 727–730
Fences:
  Partial payments on 100
  Removal and disposal of 111–116
Fencing (see also Fence materials)
  Barbed wire and farm 511
  Chain link 509, 511–512
  Construction methods 509–513
  Corners 510
  Description 509
  Existing connections with new 509–510
  Gates 513
  Line posts 511
  Materials 509
  Measurement 513
  Metal posts 511
  Partial payments on 100
  Payment 514
  Posts 509–512
  Quality requirements 727–730
  Reconstructed 512–513
  Standard 510–511
  Wire, barbed and woven 511
Fertilizers and additives, landscaping 180
  Commercial 161, 733, 735
Fertilizing, seeding and 163–164
Field assembling and riveting, steel structures 407–408
Field inspection, structural plate pipe 459
Field painting, steel structures 408

PAGE
Filled joints, concrete structures 347
Fillers, commercial mineral 677
Fillers, joint 685
Final acceptance 41
  Cleanup 28–29, 81
  Inspection 41
  Payment 100–101
Financial statement of bidders 11
Fine aggregates:
  For grout and mortar sand 683–684
  Portland cement concrete 309–310
  Portland cement products 682–683
Finished surface, portland cement treated base 218–219
Finishing:
  Bearing and base plates 394
  Concrete structures 350–354
    Bonded grout surface 352–354
    Fine surface 351–354
    Formed surface 351
    Horizontal surface 350–351
    Ordinary surface 351
    Rubbed surface 352
  Plantmix bituminous base 208
  Plantmix bituminous pavements—general 238–239
  Plantmix bituminous surface 244
  Portland cement concrete pavements 296–299
  Roadmix bituminous surface 256–257
Fire:
  Hydrants 71
  Prevention and control, forest protection 66–67
Fittings, guardrail materials 718
Fixed joints and bearings, expansion and; concrete structures 347–349
Flagging protection, railroad 59
Flagmen 624–625, 626
Flame cutting, steel or wrought iron 394–395
Flume downdrains 469–472
Flushing and testing, irrigation systems 194–195
Footings, depth of; concrete structures 333
"Force account work" (see also Extra and force account work)
  Claims for adjustment and disputes 41–42
  For "special detours" or "maintain base" 26
Forest protection 66–67
Forfeiture of proposal guaranty 21
Forged steel products, galvanizing of 705
Form clamps or bolts, concrete structures 336
Formed concrete, curing of, concrete structures 349
Forms:
  Concrete structures 333–337

Forms—*continued* PAGE
Corrugated metal ... 337
Curbs and gutters ... 492
Portland cement concrete pavement ... 286–287
Prestressed concrete members ... 360–361
Removal of ... 346–347
Over or in vicinity of railroads ... 335
Setting ... 287–288
Foundation:
Embankment ... 125
Fill:
Compaction of ... 153
Construction methods ... 153
Description ... 153
Measurement ... 153–154
Payment ... 154
Watering of embankment areas ... 157–159
Foundations, removal and disposal of ... 111
Frames and grates, painting of ... 502
Free haul distance ... 141
Frontage road or frontage street, defined ... 5
Fuel tax, refund of ... 18

G

Galvanized guardrail ... 521–522
Galvanizing:
Hardware ... 705, 725
Line posts ... 729
Materials ... 705
Products ⅛" and thicker ... 705
Rail elements ... 705
Gaskets ... 685
Gates:
Drive ... 730
Fencing ... 513, 729–730
Metal ... 729–730
Posts ... 512
Valves ... 738
Irrigation systems ... 187
Walk ... 730
Wire mesh ... 730
Gauge, meaning of ... 85–86
Girders, slabs and columns:
Concrete structures ... 342
Precast prestressed concrete ... 359–368
Gradation requirements, portland cement concrete aggregates ... 309–310, 679–684

PAGE
Grade separation, defined 58
Grades and lines, construction stakes 35–36
Grading operations:
Roadway 117
Watering of for dust control 157–159
Grading requirements tables, base aggregates 672–674
Granular backfill 147–148
Grates, frames and, painting of 502
Gravel (see Aggregates, base and surfacing)
Gray iron castings 695
Grid rollers 131
Grout:
Aggregate, requirements for 683–684
Finish, concrete structures 352–354
Grouted riprap downdrains 470
Grubbing, clearing and (see also Clearing and grubbing) 105–109
Guardrail materials 717–718
Paint for 701
Timber posts for 713
Guardrail 519–523
Construction methods 520–522
Description 519
Galvanized 521–522
Material requirements 717–718
Materials 519
Measurement 522
Painting 520–521
Payment 522–523
Posts 519, 520, 521
Reconstructed 522
Reflectors 519
Removal and disposal of 111
For reuse 113
Guide posts, culvert markers and (see also Culvert markers and guide posts) 525–526, 719–721
Guide signs (see Signs)
Gutter construction, curb and (see also Curbs, gutters and sidewalks) 491–496
Guying, staking and, landscaping 177

H

Handling materials 53
Hardware:
Bolts, nuts, dowels and drift bolts 725
Galvanizing of 705, 725
Materials covered 725
For steel structures 387–392

Hardware—*continued* PAGE
For timber structures 413
Washers 725
Hauling equipment:
For bituminous mixtures 234
Contractor's responsibility for damage caused by 38–40
Hay or straw mulch materials 735–736
Headwalls:
Pipe culvert 436
Placing concrete in 333
Structural plate pipe 462
Heavy riprap 477
High strength steel 691
High tensile strength:
Alloy bars 698
Bolts 691
Seven-wire strand 697–698
Highway:
Defined 5
Opened by permit, restoration of 56
Signs (see Signs)
Holes:
For bolts, dowels, rods and lag screws; timber structures 413
Pin holes 403–404
Rivet 384–386
Subpunching of rivet 387
Holidays:
Defined 5
Limitation of operations on 75
Hose bibs, irrigation systems 188–189
Housing, removal of; concrete structures 346–347
Humus 733, 735
Hydrated lime 654

I

Increased or decreased quantities and change in character of work 23–25, 42
Information available to bidders 11
Injury:
To persons, compensation for 63
To work, contractor's responsibility for 69, 82
Inlets, catch basins, manholes and 473–476
Removal of 112
Inspection:
By engineer 36–37
By federal agencies 56

Inspection—*continued* PAGE
Final 41
Of materials 36–37, 53
Pipe culverts 435
Plant 52
Of plant material, landscaping 171
Of stored materials 53
Structural plate pipe 459
Structural steel 382–384
Stud shear connectors, steel structures 400–402
Timber 507
Timber piles and piling 426, 507
Of work 36–37, 41, 52
By utility corporations 37
Inspector, authority and duties of 36
Defined 5
Installation:
Irrigation systems 192–194
Of permanent signs 648–649
Of temporary signs 637
Institute of Electrical and Electronics Engineers 2
Interpretation of plans and specifications by engineer 31–33
Iron:
Gray iron castings 695
And steel use items, paint for 701–702
Wrought iron plates 695
Irregularities, proposal 15
Irrigation systems:
Adjusting 195
Automatic controllers 185–186
Backfill 195
Backflow preventers 188, 192
Conduits 192, 193
Construction methods 190–195
Control tubing 185
Copper 191
Installation of 194
Control valves 187
Description 185
Drain valves 188
Excavation for 190
Adjacent to trees 190–191
Flushing and testing 194–195
Gate valves 187
Hose bibs 188–189
Installation 192–194
Jointing 191
Materials 734
Measurement 195–196

Irrigation systems—*continued* PAGE
Payment 196
Pipe and fittings 185
Piping 191, 442
Quick coupler valves 187–188
Sprinkler connections 193, 194
Sprinkler heads 186
Testing, flushing and 194–195
Timber for minor irrigation structures 506
Vacuum breakers 189–190
Valve boxes 188
Valve protection sleeves 186
Watering 177–178

J

Jacked pipes; pipe culverts 437
Joint material 685–686
Jointing, irrigation systems 191
Joints:
Concrete structures 344–346, 347–349
Corrugated metal pipe 453
Curbs and gutters 492–493
Mortar 446
Plantmix bituminous open-graded surface 247
Plantmix bituminous pavements 240
Portland cement concrete pavement 292–296
Portland cement treated base 219–220
Reinforced concrete pipe 445–447
Rubber gasketed 447
Steel structures 394
Jute matting:
Material requirements 736
Placing of 165–166

L

Labor:
Fair Labor Standards Act 56–57
And material bond 20
Laboratory, defined 5
Lacing bars, steel structures 395
Laminated panel, permanent signs 642–643
Landscaping (see also Roadside materials)
Construction methods 172–181
Description 169
Existing facilities, protection of 180

Landscaping—*continued* PAGE
Fertilizers and additives 180
Handling and shipping 170–171
Inspection of plant material 171
Lumber 172
Materials 169–172
Measurement 181–182
Mulch, use of 176
Nomenclature 169
Payment 182–183
Planter boxes 172–173
Plant establishment work 180–181
Planting:
Areas, preparation of 172–174
Beds 173
Holes 173
Layout of 172
Trenches 174
Plant materials, quality of 169–170, 733–734, 736–737
Pruning 177
Replacements 179
Staking and guying 177
Storage, temporary 171–172
Substitution of plants 171
Water for 723
Watering 177–179
Laws to be observed 55
On wages and conditions of employment 103
Laying pipes:
Culvert 437, 445–447, 452
Corrugated metal and metal arch 451–452
Reinforced concrete 445–447
Underdrains 466–467
Legal relations and responsibility 55–72
Explosives, use of 62–63
Fair Labor Standards Act 56
Forest protection 66–67
Laws to be observed 55
Legal rights, no waiver of 71–72
Liability insurance 61–62
Liability for subcontractor 64, 73–74
Materials, supplies and labor 64, 69
Patents or copyright 55–56
Permits, licenses and taxes 55
Personal liability of public officials 63, 71
Property and landscape, protection and restoration of 64–66
Public convenience and safety 57–58
Railroads, relations with 58–61
Relief from maintenance and responsibility 68–69

Legal relations and responsibility—*continued* PAGE
Responsibility for work and materials, contractor's....69–70
Restoration of surfaces opened by permit.... 56
Sanitary provisions.... 57
Termination of contractor's responsibility.... 82
Utility properties....56, 64, 70–71
Workmen's Compensation Act.... 63
Length of bridge structure, defined.... 2
Liability insurance....61–62
Licenses, permits and taxes.... 55
Lightweight aggregates....681–682
Lightweight concrete for structures
Admixtures.... 369
Aggregates, storage of.... 372
Classification and proportions....372–373
Concrete making properties....369–370
Construction methods....370–374
Description.... 369
Materials....369–370
Measurement....374–375
Mixing.... 374
Payment....375–376
Requirements and test methods for....369–370
Limitation of operations....75–76
Line posts....511, 727–729
Certificates.... 727
Paint for.... 729
Lines and grades, construction stakes....35–36
Liquid asphalts:
Average weights and volumes table.... 90
Curing products tables....661–663
Demerit schedule.... 664
Temperature table.... 267
Live loads, concrete structures....354–355
Load:
Restrictions on concrete structures....354–355
And speed restrictions....38–40
Testing, piling....425–426
Local materials:
Arrangements with owners....45–47
Documents evidencing arrangement with property owners.... 45
Found in vicinity of work....44–47
On work.... 28
Investigation of, by bidder or contractor.... 46
Owned by U.S. Government.... 47
Partial payments on....97–98
Possible sources....44–47
Samples and tests....48–51

PAGE
"Loose measurement" 89
"Low alkali cement" 651
Lumber:
For landscaping 172
Preservative treatments for 505–507
Quality requirements for 713

M

"Maintain base" 625
Special detours and 626
Maintenance:
During construction 40
Of embankment material 134
Relief from 68
Of roadway or structure, failure to maintain 40–41
Of traffic: (see also Accommodations for traffic)
During construction 25–28
During removal of structures 111
During surface treatment 274
During suspension of work 26–27, 78
Major contract item, defined 5
Malleable castings 695
Manholes, inlets, catch basins and 473–476
Removal of 112
Manual on Uniform Traffic Control Devices for Streets and Highways 2
Manufacturers' warranties or guaranties 43–44
Marker posts, metal 529–530
Markers:
Culvert (see Culvert markers and guide posts) 525–526, 719–721
Metal posts 529–530
Monument (see also Monuments) 529–530
Right of way (see also Right of way markers) 527–528, 702–703
Timber, quality requirements 713
Marking and shipping, structural steel members 404
Masonry:
Blocks, roadside materials 738
Removal and disposal of 114
Stone for 684
Materials:
Accompanied by certificate of compliance 51
Contractor's responsibility for 69–70
Control of 43–54
Damaged 69
Defined 6
Department furnished 54

Materials—*continued* PAGE
Details....651–738
Excavated....114, 120–121
Found on work (see Local materials)
Guaranty on.... 17
Handling of.... 53
Inspections:
Plant.... 52
Records of.... 44
Local (see Local materials)
Measurement of (see various sections covering items of work)
Non-perishable, disposal of.... 111
Outside highway right of way, disposal of.... 67
Rights in and use of materials found on the work.... 28
Roadside production of.... 74
Salvage of excavated....113–114
Samples and tests....48–52
Storage of....52–53, 59, 69–70
Surplus, excavated....120–121
Unacceptable.... 53
Unusable, perishable, disposal of.... 111
Matting, jute; erosion control....165–166
"Measured in the vehicle".... 89
Measurement and payment (see also sections for various items of work)....85–101
Bituminous tables, weights and volumes.... 90
Common carrier rate adjustments....96–97
Eliminated items.... 96
Extra and force account work....94–96
Partial payment....97–100
Quantities, measurement of....85–92
Scope of payment....92–94
Median, defined.... 6
Mesh, wire, fence materials.... 730
Metal bin-type retaining walls (see also Retaining walls, metal bin-type)....487–489
Metal pipe and drains....689–690
Physical properties and tests....689–690
Scope.... 689
Metal posts:
And braces....728–729
For chain link fence.... 511
For culvert markers and guide posts.... 719
For fence materials....728–729
Marker....529–530
Tubular.... 728
Metal, miscellaneous.... 695
Methods and equipment (see also Equipment)....76–77
Substitute.... 77

Mineral aggregates: PAGE
For base courses....671–674
Base and surfacing materials, watering....157–159
For bituminous courses....675–678
For portland cement products....679–684
Mineral filler, commercial.... 677
Miscellaneous:
Concrete items, paint for.... 703
Iron, paint for.... 702
Metals.... 695
Timber structures, paint for....702–703
Misfits, steel structures.... 408
Mixing methods for:
Bituminous mixtures....227–234, 237–238, 254–256
Concrete....288–289
Concrete structures.... 339
Lightweight concrete.... 374
Plantmix bituminous pavement....237–238
Portland cement treated base....211–216
Plantmix....213–216
Roadmix....211–213
Monuments....529–530
Protection of by contractor.... 64
Mortar:
Aggregate requirements for....683–684
Bands of, for non-reinforced concrete and clay pipe.... 441
Joint, for reinforced concrete pipe.... 443
"Low alkali cement" used in.... 651
Motor fuel tax refund.... 18
Motor graders, for roadmix bituminous surface.... 252
Mulch:
Application of asphalt emulsion.... 165
Asphalt emulsion used in.... 162
Blowers.... 176
For erosion control....161–162, 165
Hay or straw....735–736
Humus.... 176
For landscaping.... 176
Quality requirements....735–736
Spreading.... 165
Wood cellulose fiber.... 736
Wood chips and shavings.... 736

N

Nails, fence materials.... 729
National Electric Code....2, 533
National Electrical Manufacturers Association....2, 533
Neoprene, for elastomeric bearing pads....731–732

PAGE
Nomenclature for plant names; landscaping 169
Non-perishable material, disposal of 111
Notice to contractors 11
Defined 6
Notice to proceed 74–75
Defined 6
Nuisance, dust 72
Nuts:
Galvanizing of 705
For signs 708
For steel structures 381

O

Obstructions (see also Removal of structures and obstructions) 111–116
On-site mixed concrete 322–323
One-way traffic 25
Open joints, concrete structures 347
Opening of proposals, public 16
Openings in the highway, restoration of 56
Operations (see Work)
Order of preference, plans and specifications 33
Overbreak, excavation and embankment 120
Measurement and payment for 135–136
Overhaul:
Description 141
Measurement 141
Payment 141–142
Overhead structures, protection of 64

P

Pads, elastomeric bearing 349
Painting:
Application, general 498–499
Construction methods 498–503
Description 497
Field cleaning, structural steel 501–502
Frames and grates, structural steel 502–503
Guardrails 520–521
Machine finished surfaces 502
Materials 497
Number of coats 498
Payment 503
Prepared paints 497
Proprietary materials 497

Painting—*continued* PAGE
Raw materials 497
Steel structures 404, 408
Steel surface preparation 499–501
Structural steel 501–503
Timber 417, 503
Weather conditions 498
Paint materials (see also Galvanizing)
Bridge railings 702–703
Cattle guard wings 702–703
Certificates for 701
For concrete end posts 703
For concrete use items 703
For guardrail 701
For iron and steel use items 701–702
For line posts 729
Materials covered 701
For miscellaneous concrete 703
Miscellaneous iron 702
Miscellaneous timber structures 702–703
Physical properties and tests 701–703
For raised traffic bars 703
Right of way markers 702–703
Sign posts 702–703
Standard metal rail 701
Steel bridge railing 701
Target plates 720–721
For timber use items 702–703
Paleontological objects, preservation of 64–65
Partial payments:
For signs and barricades 99–100, 639
Schedule 98
Patching, concrete structures 350
Patents 55–56
Pavements, bituminous plantmix:
Aggregates 227, 233, 236–237
Breakdown rollers 235
Commercial mineral filler 227
Composition of mixtures 225–227
Construction methods 227–241
Description 225
Existing surface, preparation of 236
Finish rollers 236
Finishing, spreading and 238–239
Hauling equipment 234
Joints 240
Materials 225–227, 236
Measurement 241–242
Mixing 237–238

Pavements, bituminous plantmix—*continued* PAGE
Mixing plants....227–234
Pavers....234–235
Payment.... 242
Pneumatic-tired rollers.... 235
Preparation of aggregates....236–237
Rollers....235–236, 240
Rolling....239–240
Spreading and finishing....238–239
Surface tolerances.... 240
Surfacing miscellaneous areas....240–241
Weather limitations.... 236
Pavements, old, removal and disposal of....111–112
Pavements, portland cement concrete:
Aggregates, grading limits of combined....281–282
Batch plant and equipment....282–285
Classification and proportions....280–282
Compaction of....290–292
Concrete saw.... 286
Construction methods....280–302
Curing.... 300
Description.... 279
Equipment....282–287
Finishing....296–299
Finishing equipment....285–286
Forms....286–287
Gradation requirements.... 279
Grade, preparation of.... 287
Joints....292–296
Materials....279–280
Measurement....302–306
Mixers.... 285
Mixing....288–289
Payment....306–307
Placing....289–290
Properties and tests.... 280
Protection of pavement....300–302
Reinforcement.... 288
Riding tolerances....299–300
Setting forms....287–288
Spreading, compacting and shaping....290–292
Thickness requirements for....302–306
Vibrators....285–286
Pavers, bituminous....234–235
Paving asphalts, measurement of....89–90
Payment:
Contract item, defined.... 3
Extra work (see Extra work)
Final acceptance and....100–101

Payment—*continued*
Force account (see Force account work) PAGE
Guarantee by contractor 64
Measurement and (see also sections for various items of work) 85–101
Partial 97–100
Schedule of partial payments 98
Scope of 92–94
Of taxes 55
For work or operations performed by railroad 61
Penetration of piles, bearing value and 423–424
Pentachlorophenol 505
Permanent signs (see also Signs, permanent) 641–649, 707–709
Permit, restoration of surfaces opened by 56
Permits, licenses, and taxes 55
Personal liability of public officials 63, 71
Persons, responsibility for injury to, by contractor 63
Piers, placing and compacting at 149
Piles:
Preservative treatments for 505–507
Steel 695
Steel shell for 695
Timber 711
Treated 412
Piling:
Bearing value and penetration 423–424
Cast-in-place concrete 420–421, 428–430
Construction methods 419–431
Cutoff and extensions 424–425
Description 419
Driving of 421–423
Equipment 420–421
Heads, treatment of 427
Lengths of 419
Load testing 425–426
Materials 419
Measurement 431
Payment 431–433
Precast concrete 419, 420, 422, 425, 427–428
Preservative treatment of 505–507
Steel 430–431
Test 420
Payment for 432
Timber 426–427
Timber caps 427
Pilot cars 625, 626
Pins and rollers 692
Pins, rollers and pin holes 403–404
Pipe brackets, sign materials 707–708
Pipe lines, abandoned, removal and disposal of 111

	PAGE
Pipe and pipe fittings:	
Irrigation systems	185, 191, 442
Material requirements	737
Pipes (see also Culverts)	
Aluminum alloy for	693
Aluminum corrugated metal pipe and aluminum arch culverts	455–456
Bituminous coated corrugated metal pipe and pipe arches	689
Bituminous coated corrugated metal pipe for underdrains	690
Bituminous fiber pipe	687–688
Catch basins, manholes and inlets; pipe or tile placed in masonry	474
Clay pipes	687–688
For underdrains	465
Concrete and clay pipe and drains	687–688
Corrugated aluminum pipe for underdrains	690
Corrugated metal pipe and metal arch pipe	451–454
Corrugated metal pipe and pipe arches	689
Culvert pipes (see also Culverts)	435–440
Installation of pipe:	
In new embankment	444–445
In underdrain outlets	467
Irrigation pipe	185, 191, 442
Metal pipe and drains	689–690
Non-reinforced concrete and clay pipe	441–442
Quality requirements	687
Perforated:	
Bituminous fiber pipe	688
Concrete pipe	687
Concrete pipe for underdrains	465–468
Metal pipe	689
Reinforced concrete pipe	443–448
Quality requirements	687
Sewer (see Sewer pipes)	
Structural plate pipe and pipe arch culverts	457–463
Underdrains, pipes for (see also Underdrains)	465–468, 687–690
Welded seamless steel pipes	691
Piping	185, 191, 737
Pits:	
Backfilling	111
Protection of	29
Plans, defined	6
Plans and specifications:	
Change in by contractor	27
Conformity with	32
Contract modification	32
Coordination of	33

Plans and specifications—*continued* PAGE
Examination of....13–14
Intent of.... 33
Interpretation of....31, 33
Order of preference.... 33
And working drawings....31–32
Plant inspection.... 52
Planter boxes, landscaping....172–173
Planting areas, landscaping....172–174
Planting trenches.... 174
Plantmix:
Bituminous base (see also Bituminous Plantmix base)....207–209, 675–676
Bituminous open-graded surface (see also Bituminous open-graded surface)....247–249, 677
Bituminous pavements (see also Pavements, Bituminous plantmix)....225–242
Plants, landscaping (see also Planting areas; Roadside materials)
Establishment work....180–181
Handling and shipping....170–171
Inspection of.... 171
Nomenclature for names of.... 169
Pruning.... 177
Quality of....169–170, 733–734, 736–737
Replacements.... 179
Staking and guying.... 177
Storage, temporary....171–172
Water for.... 723
Watering....177–179
Plates:
Bearing....406, 407
Galvanizing of....705, 707
Steel....393, 394
Stiffener, galvanizing of.... 707
Web....395–396
Wrought iron.... 695
Platform scales....87–88
Plywood for forms, concrete structures....336–337
Pneumatic tired compactors and rollers....131–133, 235
Pole lines, protection of.... 64
Portland cement concrete (see also Lightweight concrete)
Admixtures....310–312
Aggregates:
Grading limits of combined.... 282
Storage of.... 316
Cement, protecting and sampling....315–316
Classifications and proportions....316–317
Concrete making properties....312–314
Construction methods....315–331

Portland cement concrete—*continued* PAGE
Curing of....326–328
Description....309
Equipment....315, 319–325
Gradation requirements....309–310
Hand mixing....326
"Low alkali cement" used in....651
Machine mixing....321–326
Materials....309–314
Materials details of portland cement....651
On-site mixed concrete....322–323
Pavements (see Pavements, portland cement concrete)
Payment....331
Proportioning methods....317–321
Proportions, classifications and....316–317
Protecting and sampling cement....315–316
Ready-mixed concrete....323–326
Requirements and test methods....312–314, 651
Retempering....326
Riprap, sacked (see also Riprap)....477, 479–480
Structures (see Concrete structures)
Test methods, requirements and....312–314
Tricalcium silicate used in....651
Truck mixer or agitator....323–326
Water for....723
Weather limitations....328–331
Portland cement materials details....651
Portland cement products, aggregates for (see also Aggregates, portland cement products)....679–684
Portland cement treated base....211–224
Post clamps, sign materials....707
Post-tensioning methods:
Concrete reinforcement....699
Precast prestressed concrete members....359–360
Posts:
Cattle guard....516
Concrete end, paint for....703
Construction sign....631–632
Culvert markers and guide....719–721
Fencing....510–512
Line....511, 727, 728, 729
Metal marker....529–530
Metal fence materials....728–729
Removal of....113
Right of way markers....527–528
Steel pipe for....708
Temporary sign....635, 638
Timber....414, 527–528, 702–703

Posts—*continued* PAGE
Wide flange beam, galvanizing of 707
Wood 717, 727–728
Precast:
Concrete piles 420, 422, 427–428
Manholes 475
Prestressed concrete members (see Prestressed concrete members)
Preconstruction conference 79
Prequalification of bidders and contractors 11–12
Preservative treatments for timber 505–507, 519
Preservatives, timber 715
Pressed steel products, galvanizing of 705
Pressure:
Conduits, concrete and clay pipe for 687–688
Pipe, reinforced concrete for 448
Prestressed concrete members:
Anchorages and distribution 361–362
Construction methods 359–367
Curing 366
Description 359
Enclosures 362
Forms 360–361
Handling 367
Materials 359
Measurement 367
Payment 367–368
Prestressing methods 359–360
Prestressing steel 362–366, 697–699
Pretensioning 359–360
Reinforcement and anchorages, testing of 698–699
Shipping 367
Prime coat 265–268
Privilege taxes 55
Production sources, roadside 74
Profile grade, defined 6
"Progress schedule" 75
Progress of work, prosecution and 73–83
Project, defined 6
Proof rollers 133
Property marks, protection and restoration of 64–66
Proportioning methods for:
Portland cement concrete 317–321
Portland cement concrete pavements 280–282
Proportions, classification and; portland cement concrete 316–317
Proposal:
Change in staging or sequence of operations 27
Consideration of 19

Proposal—*continued* PAGE
Defined 6
Delivery of 16
Eliminated items from 96
Form, contents of 12
Defined 6
Signing of 15
Guaranty 16
Defined 6
Forfeiture of 16, 21
Return of 20
Irregular 15
Preparation of 14–15
Public opening of 16–17
Quantities, interpretation of 13
Rejection of 17
Requirements and conditions 14–15
Withdrawal or revision of 16
Prosecution and progess of work 73–83
Protection:
Of archeological and paleontological objects and artifacts 64–65
And curing (see Curing)
Forest 66–67
Of poles 64
Portland cement concrete 315–316
Of pavement 300–302
And restoration of property and landscape 64–66
Of trees and shrubs 64, 105
Pruning, landscaping 177
Public, convenience and safety (see also Accommodations for public traffic) 57–58
Construction and temporary signs for safety of 629–639
Officials, personal liability of 63, 71
Public Service Commission 533
Pumping concrete 343
Pumping water 339

Q

Qualification of bidders 11–12
Quality of materials and source of supply 43–44
Quantities, altered (see Increased or decreased quantities)
Interpretation of 13
Measurement of (see also sections for various items of work) 85–92
Quick coupler valves, irrigation systems 187–188
Material requirements 738

R

Rail: PAGE
- Bridge, aluminum alloy used in ... 693
- Elements, galvanizing of ... 705
- Members, guardrail materials ... 717
- Posts ... 405
  - Finishing of ... 384
- Standard metal, paint for ... 701–702

Railing:
- Steel bridge, paint for ... 701–702
- Timber bridge, paint for ... 702–703

Railroad crossing, defined ... 58

Railroads:
- Clearance markers ... 59
- Concrete forms over or in vicinity of ... 335
- Employees' services ... 60
- Flagging protection ... 59
- Movement or adjustment of telephone, telegraph or signal facilities ... 60–61
- Pay rates ... 60
- Protective liability and property damage insurance ... 61–62
- Rules and regulations with respect to highway contractors ... 58–61
- Work or operations performed by ... 60

Raised traffic bars ... 531–532
- Paint for ... 703

Ready-mixed concrete ... 323–326

Reaming, steel structures ... 387, 408

Reflector plates, guardrail ... 718

Reflectorization of:
- Guardrails ... 718
- Signs ... 630, 636–637, 645–648

Reflectors, culvert markers and guide posts ... 525, 721
- Guardrails ... 519, 718

Refund of motor fuel tax ... 18

Reinforcement:
- Bar steel ... 697
- Concrete ... 338, 697–699
- Fabricated steel bar or rod mats ... 697
- Materials covered ... 697
- Physical properties and tests ... 697–698
- Portland cement concrete pavement ... 288
- Prestressing steel ... 697–699
- Welded steel wire fabric ... 697

Reinforcing steel ... 377–380

Relay culvert pipes ... 453–454
- Removal of ... 114

Relief from maintenance and responsibility ... 68–69

Removal of structures and obstructions (see also Disposal of materials; types of structures and obstructions) PAGE
Abandoned pipe lines 111
Bituminous pavement 112
Bridges 111–112
Brush 509
Buildings 111
Catch basins 112
Closing culverts 113
Construction methods 111–115
Culvert markers 111
For reuse 113–114
Culverts 111–112
Curbs, gutters and sidewalks 112
Description 111
Drainage structures 111–112
Disposal of materials 114–115
Falsework, forms and housing 346–347
Fences 111
For reuse 113
Foundation excavation 144
Foundations 111
Gates for reuse 113
Guardrail 111
Designated for reuse 113
Guide posts 111
Designated for reuse 113
Manholes, catch basins and inlets 112
Measurement 115
Non-perishable material 111
Objects or disturbances caused by contractor's operations 28–29
Pavements 112
Payment 115–116
Perishable material 111
Roots 106
Rubbish 29
Salvable material 111
Salvage from 113–114
Structural steel specified for salvage 114
Structure excavation material 144
Stumps 106
Substructures of existing structures 112
Temporary signs and barricades 637–638
Timber or piling designated to be salvaged 114
Trees 106, 509
Unacceptable and unauthorized work 37–38
Underground structures 64
Unsuitable material 28–29, 60, 119, 135

	PAGE
Rental of equipment:	
For accommodating traffic	626
Measurement and payment	90–92
Reset culvert markers and guide posts	525
Resident engineer, authority and duties of	36
Restoration of property and landscape	64–66
Surfaces opened by permit	56
Restrictions, load and speed	38–40
Retaining walls, metal bin-type	487–489
Backfill for	150
Retempering of portland cement concrete	326
Return of proposal guaranty	20
Reuse of materials after removal of structures	113–114
Riding tolerances, portland cement concrete pavements	299–300
Right of way:	
Defined	7
Delays	34–35, 82–83
Furnishing of	71
Right of way markers	527–528
Paint for	702–703
Timber, quality requirements of	713
Rights in materials found on work	28
Riprap	477–480
Materials	684
Riprap structures:	
Construction (Useable materials from old structures)	114
Downdrains	470
Rivet holes	384–386
Subpunching of	387
Rivets	386
Road, defined	7
Roadbed, defined	7
Roadmix bituminous surface (see Bituminous roadmix surface)	251–260
Roads in ditch and dike areas	66
Roadside, defined	7
Development, defined	7
Roadside materials (see also Erosion control; Irrigation systems; Landscaping)	
Certificates and samples	733–734
Control tubing	738
Fertilizer, commercial	733, 735
Gate valves	738
Humus	733, 735
Irrigation materials	734
Jute matting	736
Masonry	738
Mulch	735–736
Pipe and pipe fittings	737
Plants	733–734, 736–737

Roadside materials—*continued* PAGE
Production sources 74
Quick coupler valves 738
Requirements 733–734
Scope 733
Seeds 734, 737
Top soil 733, 734
Tree ties 737
Roadside signs 630–631
Roadway:
Construction, drainage during 122–123
Defined 7
Excavation and embankment 117, 118
Overhaul on 137, 141–142
Grading 117
Width, defined 2
Rock cuts in excavating 119–120
Rock embankment compaction:
Construction methods 129–130
Equipment 130–133
Testing 129, 133–134
Rock embankment placement 127–128
Rock materials, measurement for 135–136
Rod mats reinforcement, for concrete 697
Rolled material; straightening of 384
Defects 691
Rolled steel products, galvanizing of 705
Rollers and rolling:
Breakdown 235
Finish 236
Plantmix bituminous base 207
Plantmix bituminous open graded surface 247
For plantmix bituminous pavements 235–236, 239–240
Plantmix bituminous surface 243
Pneumatic-tired 131–132, 235
Proof rolling 129, 133–134
Roadmix bituminous surface 252
Sheepsfoot or tamping 130–131
For surface treatment 273–274, 276–277
Roots, removal of 106
Round timber piles 711
Rounded and transition slopes 139–140
Rubbed finish, concrete structures 352
Rubber gasketed joints, reinforced concrete pipe 447
Rubber gaskets 685
Rubbish, removal of 29

S

PAGE
Safety precautions, contractor's compliance with....57–58
Salvaging of materials:
From removal of structures....113–114
Structural plate pipe and pipe arch culverts.... 457
Sampling and protection of portland cement concrete....315–316
Samples and tests (see also sections covering various items of work)....48–51
Sand blotter:
Aggregates for bituminous courses.... 678
For prime coat....265, 267
For seal coat....269–270
Sand for grout and mortar....683–684
Sanitary provisions.... 57
Scales, requirements for....86–88
Conveyor.... 88
Platform....87–88
Scalping for clearing and grubbing.... 107
Schedule, progress.... 75
Scope of payment....92–94
Screenings, aggregates for bituminous courses....677–678
For surface treatment....273, 275–276
Seal coat....269–271
Seed beds, landscaping.... 173
Seeding and fertilizing, erosion control....163–164
Seeds, erosion control.... 161
Quality requirements....734, 737
Selected material, base or surface....197–199
Selected material encountered in excavating....121–122
Measurement for.... 136
Sewers:
Concrete and clay pipe and drains for....687–688
Connections, non-reinforced concrete and clay pipe....441–442
Live, treatment of when abandoning manholes, catch basins and inlets.... 112
Shaping portland cement concrete pavement....290–292
Shear connector studs....396–402, 692
Sheepsfoot or tamping rollers....130–131
Sheet aluminum (see Aluminum sheets)
Shims, aluminum alloy.... 693
Shop assembly, steel structures....392–393
Painting.... 404
Riveting....386–387
Shoulder, defined.... 7
Sidewalk (see Curbs, gutters and sidewalks)
Defined.... 7
Sign:
Background....636, 645–646

Sign—*continued* PAGE
Faces, preparation of....636, 643–644
Illumination....616–618
Islands....648–649
Sign materials....707–709
Sign posts (see Posts)
Signals and lighting:
Ballasts....587–588, 599–601
Bonding and grounding....613–614
Conductor table....547–549
Conductors....544–549, 588, 609–613
Conduit....543, 605–609
Controller:
Auxiliary movement....559–561
Housings....567–569, 573
Phase skip unit....561–562
Vents....568, 573
Controllers:
Pre-timed....569–573
Traffic actuated....554–569
Definitions....537–539
Description.... 533
Detector foundations....540, 602–603
Detectors....578–582
Raising or relocating existing pressure-sensitive.... 620
Equipment list and drawings....534–535
Excavating and backfilling....603–604
Expansion fittings.... 544
Field tests....616–618
Flasher and flasher relay....562–563
Flashing beacons.... 596
Flashers.... 572
Flashing operations....551–552
Foundations....540, 602–603
Galvanizing.... 551
Interval timer, pedestrian....564–566
Luminaries:
Fluorescent....586–588
Incandescent.... 588
Mercury vapor....585–586
Soffit and wall mounted....588–589
Maintaining existing and temporary electrical systems....535–536
Mast arms....542, 550
Materials....539–540
Mounting brackets....577–578
Multiple circuit ballasts.... 600
Operating voltage....553–554
Optical units....574–575

Signals and lighting—*continued* PAGE
Painting....618–620
Parts lists, instruction sheets and....535
Pedestrian push buttons....582–583
Signal faces....573–576
Signals, "Walk-Don't Walk"....564–566, 573–575, 583–585
Photoelectric controls....597–598
Pre-timed controllers....569–573
Pull boxes....543–544, 605, 609
Push button posts and guard posts....542
Radio interference suppressor....554
Railroad pre-emption....552–553, 566, 573
Regulations and code....533
Reinstalling salvaged electrical equipment....620–621
Relays:
Calling detector....567
Directional detector....566
External light....563
Flasher....562–563
Overlap....564
Removing and replacing improvements....604
Safety precautions....537
Salvaging electrical equipment....620–621
Scheduling of work....536–537
Series circuit ballasts....600–601
Lighting conductors....545
Multiple relays....598–599
Multiple transformers....599
Service locations and installations....615–616
Sign lighting fixtures:
Fluorescent....592–595
Incandescent....595
Sign switches....567–568, 571–572
Signal faces....573–576
Signal head mounting....577–578
Standards, steel pedestals and posts....540–543, 604–605
Stockpiling salvaged electrical equipment....620–621
Wiring....609–613
Wood poles....550
Signs and barricades, partial payments on....99, 639
Signs, construction:
Construction methods....629–632
Contractor's responsibility....632
Description....629
Foundations....632
Lights for....632
Materials....629
Measurement....632–633
Mounting....632

Signs, construction—*continued* PAGE
Partial payments on 99–100
Payment 633
Reflectorization of 630
Removal of 631
Rental of 632
Roadside signs 630–631
In rural areas 631
Warning signs 630, 631, 632
Signs, permanent:
Aluminum sheet panels 641–642
Background 645–646
Construction methods 641–649
Cut-out letters, numerals, symbols and accessories 646–648
Description 641
Fabrication 641–643
Frame supporting 643
Installation 648–649
Islands 648
Laminated panel 642–643
Materials 641
Measurement 649
Payment 649
Quality requirements 707–709
Reflectorization 647–648
Shop drawings 643
Sign background 645–646
Sign faces 643–644, 648
Sign islands 648
Tests 649
Signs, temporary:
Background 636
Barricades and markings 635–639
Construction methods 635–638
Cut-out letters, numerals, symbols and accessories 636–637
Description 635
Installation of 637
Materials 635, 707–709
Measurement 638
New signs, partial payment on 639
Payment 638–639
Removal and re-erection of 637–638
Sign background 636
Sign faces, preparation of 636, 637
Sign posts 635, 638
Specifications covering materials used in 707–709
Tests 637
Sills, timber construction 414

PAGE
Siphons, concrete and clay pipe....687–688
Corrugated metal pipe and metal arch pipe....452–453
Reinforced concrete pipe....448, 687
Site preparation, landscaping....172
Site of work, examination of....13–14
Slabs, concrete structures....342
Precast prestressed concrete....359
Slides and slipouts, excavation and removal of....122
Measurement for....136–137
Slip joints, downdrains....469–470
Slopes:
Cultivation of....162
Excavation and embankment....120
Paving, concrete....483–485
Rounded and transition....139–140
Society of Automotive Engineers....2
Soil (see Top soil)
Sources, of local material....44–47
Of supply and quality requirements....43–44
"Special detours," payment for....26, 626–627
Special provisions:
Coordination of plans, specifications, supplemental specifications, and....33
Defined....7
"Specialty items" for contract....74
Specifications:
Cited....51–52
Conformity with....32–33
Coordination of....33
Defined....8
Examination of....13–14
Interpretation of plans and....33
Preference, order of....33
Repetition of expressions, avoidance of....10
Supplemental....9
Speed restrictions, load and....38–40
Spikes, timber structures....415, 416
Splices, reinforcing steel....378–379
Steel structures....387, 396
Spray nozzles, irrigation systems....195
Spreading and finishing (see also Finishing)
Plantmix bituminous pavements....238–239
Plantmix bituminous surface....244
Portland cement treated base....216–218
Portland cement concrete pavement....290–292
Roadmix bituminous surface....256–257
Sprinklers:
Irrigation systems....195

Sprinklers—*continued* PAGE
Connections....193, 194
Heads.... 186
Stainless steel bolts.... 691
Stakes, construction, lines and grades, preservation of....35–36
Staking and guying of plants.... 177
Standard steel.... 691
Standards:
Federal Specifications and Standards.... 2
Fencing, metal gates for....729–730
Metal rail, paints for.... 701
United States of America Standards Institute.... 2
Staples, brace wire and nails.... 729
State, defined.... 8
State-furnished materials.... 54
Steam cleaning, painting....500–501
Steel (see also Structural and eyebar steel)
Bridge railing, paint for.... 701
Guardrail materials....717–718
Joints, concrete structures....347–348
Light standards, paint for.... 702
Paint for structural steel....501–503
Piles....430–431, 695
Pipe for posts.... 708
Tubular, fence material.... 728
Welded seamless.... 691
Plates, edge planing.... 393
Surface finish.... 394
Prestressing....362–366
Reinforcing (see Reinforcing steel)....377–380
Rolled material, straightening of.... 384
Sheets, for culvert markers and guide posts....719–720
Guardrail construction (Reflector plates).... 718
Shell for piles.... 695
Standard.... 691
Steel structures:
Abutting joints.... 394
Annealing and stress relieving.... 403
Bearing and anchorage plates....406–407
Beginning of work, notice of.... 382
Bolt lengths table.... 389
Bolt tension:
Calibrated wrenches for....391–392
Table.... 391
Turn of nut method.... 392
Bolts and bolted connections....387–392
Bolts, nuts and washers, material requirements.... 381
Construction methods....381–408
Description.... 381

Steel structures—*continued* PAGE
Drawings, shop....381–382
Edge planing....393
Elastomeric bearing pads....407
End connection angles....395
Erection methods and equipment....404–405
Facing of bearing surfaces....394
Falsework....405–406
Field assembling and riveting....407–408
Field painting....408
Flame cutting....394–395
Inspection and testing of....382–384
Lacing bars....395
Marking and shipping....404
Materials....381
Measurement....408–410
Misfits....408
Paint for iron and steel use items....701–702
Painting (see also Structural steel)....404, 408
Payment....410
Pins, rollers and pin holes....403–404
Rail posts, erection....405
Finishing....384
Rivet holes....384–386, 387
Rivets....386
Rolled material, straightening of....384
Rollers....403
Shipping members....404
Shop assembly....392–393
Shop painting....404
Shop riveting....386–387
Stiffeners, fit of....402–403
Storage of structural material....384
Stress relieving, annealing and....403
Stud shear connectors....396–402
Subpunching, drilling and reaming....387
Washer dimensions table....390
Web plates....395–396
Weights, calculated....409
Welding....402
Stiffener plates, galvanizing of....707
Stiffeners, fit of, steel structures....402–403
Stone for masonry and riprap....684
Storage of:
Aggregates, lightweight concrete....372
Materials....52–53
Materials near railroad tracks....59
Plants, landscaping....171–172
Portland cement concrete aggregates....316

Storage of—*continued* PAGE
State paid for furnished materials....69–70
Structural steel materials.... 384
Timber and lumber....411–412
Storm drains, concrete and clay pipe for.... 687
Straightening, rolled structural steel materials.... 384
Straps, bars and braces for signs.... 708
Straw mulch materials....735–736
Stream channels (see Ditch and channel)
Street, defined.... 8
Stress relieving, steel structures.... 403
Stringers for signs.... 708
For timber structures....415, 416
Strip products, galvanizing of.... 705
Structural and eyebar steel:
Cold-formed welded and seamless carbon structural tubing in rounds and shapes.... 691
Defects.... 691
High-strength, low-alloy structural manganese vanadium steel.... 691
High tensile strength bolts.... 691
Physical properties and tests.... 691
Pins and rollers.... 692
Shear connector studs.... 692
Stainless steel bolts.... 691
Standard steel.... 691
Welded seamless steel pipe.... 691
Structural steel:
Paint for.... 702
Painting....501–503
Surface preparation....499–501
Tubing.... 691
Weights.... 409
Structural timber, quality requirements for.... 713
Structures, concrete (see Concrete structures)
Structures, defined.... 8
Structures, excavation for....143–146
Structures and obstructions, removal of (see also Removal of structures and obstructions)....111–116
Structures, steel (see Steel structures)
Structures, timber (see Timber structures)
Strutting corrugated metal pipe.... 452
Strutting structural plate pipe.... 461
Stud shear connectors, steel structures....396–402
Stumps, removal of.... 106
Subcontractor, contractor's liability for claims against....64, 73
Subcontractor, defined.... 8
Subgrade:
Cement treated.... 651

Subgrade—*continued* PAGE
Defined 8
Material, watering of 157–159, 723
Paper 654
Preparation, aggregate base courses 201
Selected material base or surface 197
Subletting of contract 73–74
Subpunching, drilling and reaming 387
Substitute methods or types of equipment 77
Substitution of plants, landscaping 171
Substitution of reinforcing steel 379
Substructure, defined 8
Substructures of existing structures, removal and disposal of 112
Subsurface information 13–14
Superintendent, defined 9
On the work 33–34
Supplemental agreement 23
Defined 9
Supplemental specification, defined 9
Supply of materials, source and quality 43–44
Surety, defined 9
Responsibility of 81–82
Surface courses, water for 723
Surface tolerances (see Tolerances)
Surface treatment:
Aggregate spreader 273
Application of bituminous material 275
Application of screenings 275–276
Distributors 273
Maintaining traffic during 274
Materials 273
Preparation of surface 274–275
Rollers 273–274
Rolling 276–277
Screening 273, 275–276
Water for, quality of 723
Weather limitations 274
Surfaces:
Existing (see Existing surfaces)
Opened by permit, restoration of 56
Selected material for (see Selected material base or surface)
Treatment of (see also Surface treatment) 273–277
Surfacing:
Bituminous plantmix pavements 240–241
Bituminous roadmix surface 257–258
Materials, watering of 157–159
Miscellaneous areas 240–241

PAGE
Surplus excavated material....120–121
Measurement and payment.... 136
Survey monuments....529–530
Suspension of work:
Contractor's responsibility during.... 69
Temporary....77–79

T

Tack coat....261–263
Tamping rollers, or sheepsfoot....130–131
Target members.... 525
Target plates:
Base metal....719–720
Paint for....720–721
Tax refund, motor fuel.... 18
Taxes, permits, licenses and privilege.... 55
Telltales, installation of.... 60
Temporary signs (see Signs, temporary)....635–639, 707–709
Temporary suspension of work....77–79
Termination of contract and contractor's responsibility....81–82
Terms, definitions and....1–10
Test piles.... 420
Payment for.... 432
Testing methods by Department of Highways....51–52
Test methods for:
Aggregates for bituminous courses....675–678
Aggregates for portland cement products....679–684
Base aggregates....671–674
Bituminous materials....656–659
Compaction of rock embankment....129–134
Joint material....685–686
Lightweight concrete....369–370
Load testing....425–426
Materials....48–52
Paints....701–703
Permanent signs.... 649
Portland cement concrete....312–314
Portland cement concrete pavement....280–282
Prestressing reinforcement and anchorages for concrete....698–699
Supply lines, irrigation systems....194–195
Studs....396–402
Water.... 723
Thickness requirements, concrete pavements....302–306
Timber:
Certificates of inspection.... 713
Grades.... 713

Timber—*continued* PAGE
Measurement 89
Merchantable 107
Paint for 702–703
Painting 503
Preservative treatments for (see Preservative treatments for timber) 505–507
Preservatives 715
Quality requirements 713
Species 713
Timber piles 426–427
Caps 427
Heads of 427
Specifications of rounded piles 711
Treated 412
Timber posts 414
Guardrail posts 519, 520
Preservatives 505–507, 715
Quality requirements 713
Right of way markers 527–528
Sign posts, paint for 702
Temporary signs 635–638
Wood posts 727–728
Timber structures:
Bolts and washers 413
Bracing 414–415
Caps 414
Cattle guards (see Cattle guards)
Construction methods 411–417
Description 411
Framing 413–414
Guardrail (see Guardrails)
Holes for bolts, dowels, rods and lag screws 413
Inspection of timber 507
Laminated floors 416
Materials 411
Measurement 417
Painting 417, 503
Paints 702–703
Payment 417
Piles (see Timber piles)
Plank floors 415–416
Posts (see Timber posts)
Preservative treatments for 505–507, 715
Storage of materials 411–412
Stringers 415, 416
Structural timber and lumber, quality requirements 713
Treated timber and piling 412
Trusses 416–417

Timber structures—*continued* PAGE
Untreated timber 413
Workmanship 412
Timber use items, paint for 702–703
Time:
Completion of contract 68
Extension of contract 65, 79–80
Failure to complete work on 80–81
Tolerances:
Aggregates, type 2, class A 204
Plantmix bituminous base 208
Plantmix bituminous surface 244
Plantmix open-graded surface 248
Roadmix bituminous surface 258
Riding, portland cement concrete pavements 299–300
"Ton", meaning of 86
Top soil:
Erosion control 161, 162, 163
For landscaping 172
Material requirements 733–734
Placement of 162
Traffic control:
Bars (see Raised traffic bars) 531–532
Construction signs 629–633
Lane, defined 9
Maintenance (see Maintenance of traffic)
Manual on Uniform Traffic Control Devices 2
Permanent signs 641–649
Public convenience and safety 57–58
Temporary signs 635–639
Transition slopes, rounded and 139–140
Transverse expansion joints:
Portland cement concrete pavements 292–296
Sidewalks 493
Traveled way, defined 9
Treated timber and piling 412
Tree ties:
Landscaping 177
Materials requirements 737
Trees and shrubs:
Excavation adjacent to 190–191
Protection of 64, 105
Removal of 106–107
Tremie for concrete deposited under water 343–344
Trenches, backfilling 111
Restoration of area 29
Underdrain outlets 467
Tricalcium silicate used in portland cement 651

PAGE
Truck mixers or agitators, portland cement concrete.....323–325
Trusses, timber structures.....416–417
Tubing:
Aluminum alloy..... 693
Carbon steel structural..... 691
Control tubing, irrigation systems..... 194
Steel structure..... 691

U

Unacceptable materials..... 53
Unacceptable and unauthorized work.....37–38
Underdrains.....466–468
Backfill for.....155, 465–466
Materials for.....688–690
Underwriters' Laboratories, Inc.....2, 533
United States of America Standards Institute..... 2
Unsuitable material:
Excavation and embankment.....118–119
Measurement for payment..... 135
Perishable, destruction of..... 111
Removal of.....28–29, 60, 119
Unsuitable weather, temporary suspension of work due to.....77–78
(see also sections covering various items of work)
Untreated timber..... 413
Utility property and services:
Contractor's responsibility for.....70–71
Cooperation of contractor with.....34–35
Delays to contractor from removing and relocating of....34–35
Compensation for..... 35
Inspection of work by..... 37
Restoration of surfaces opened by permit..... 56
Right of way delays..... 35
Underground facilities not known to State..... 34

V

Vacuum breakers, irrigation systems.....189–190
Valve boxes, irrigation systems..... 188
Valve protection sleeves..... 186
Valves, quick coupler, irrigation systems.....187–188
Vanadium steel..... 691
Vibrators for concrete structures.....340–341
Vibrators for portland cement concrete pavement.....285–286
Vibratory compactors for excavation and embankment..... 133
Volumetric measurements..... 90

W

PAGE

Wages and conditions of employment 103
Waiver of legal right 71–72, 81
Walk gates, fence materials 730
Warning signs (see also Signs, construction) 58, 630
Warranties, manufacturer's 43–44
Washers:
  Cast 725
  Dimensions table 390
  Flat malleable 725
  Galvanizing of 705, 725
  For signs 708
  For steel structures 381
  For timber structures 413
Water:
  Meters 86
  Pollution control 66
  Pumping, concrete structures 339
  Quality of 723
  Retardants 653–654
  State-owned, for irrigation systems 177–178
Watering (see also sections covering various items of work) 157–159
Waterproofing and dampproofing, asphalt for 655
Waterstops:
  Concrete structures 348
  Material requirements 685–686
Weakened plane joints, portland cement concrete pavements 293–295
Weather conditions, temporary suspension of work due to 77–78
  (see also sections covering various types of work)
Web plates, steel structures 395–396
  Stiffeners, welding of 403
Weighing of materials (see also sections covering various items of work) 86–88
Weights of:
  Asphalt cement 90
  Asphaltic emulsions 90
  Liquid asphalt 90
  Reinforcing steel 379–380
  Structural steel 409
Weldability tests, stud shear connectors 397–402
Welded and seamless carbon steel structural tubing 691
Welded seamless steel pipe 691
Welded steel wire fabric reinforcement 697
Welding materials 695
Welding steel structures 402
Widening cuts, excavation 120
  Payment for 136

PAGE
Wingwalls, placing and compacting at 149
Wire:
Barbed 511, 729
Brace 729
High-tensile-strength seven-wire strand 697–698
High-tensile-strength steel wire 697
Mesh 730
Woven 511, 729
Withdrawal or revision of proposals 16
Wood cellulose fiber mulch 736
Wood chips and shavings, mulch 736
Wood posts (see also Timber posts) 717, 727–728
Work:
Character of workmen; methods and equipment 76–77
Change in character of work 23–25
Completion of portions of the work 68
Contractor's responsibility for 69–70
Control of 31–42
Day, defined 9
Default and termination of contract 81–82
Eliminated items 96
Examination of plans, specifications, contract documents, and site of work 13–14
Extra (see "Extra work")
Failure to complete on time 80–81
Force account (see Force account work)
Increased or decreased quantities 23–25
Inspection of 36–37, 52
By engineer 41, 52
By Federal agency 56
Limitation of operations 75–76
Measurement and payment (see also sections covering various items of work) 85–101
Notice to proceed 6, 74–75
Preconstruction conference 79
Prosecution and progress 73–83
Schedule 75
Removal of unacceptable and unauthorized 37–38
Relief from maintenance and responsibility 68–69
Rights in and use of materials found on the work 28
Scope of 23–29
Subletting of contract 73–74
Superintendence of 33–34
Temporary suspension of 77–79
"Working day" 75, 78–79
Defined 9
Working drawings:
Defined 10
Plans and 31–32

INDEX

	PAGE
Workmen, character of	76–77
Workmen's Compensation Act	63
Woven wire	511, 729
Wrought iron plates	695

(30)

BUREAU OF PUBLIC ROADS
RECEIVED
AUG 21 1968
LIBRARY

RECEIVED
BUREAU OF PUBLIC ROADS
JUN 4 1968
ENGINEERING & OPERATIONS

Federal Highway Administration
Bureau of Public Roads Library
Washington, D.C. 20591

08016089